USDA United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with United States Department of the Interior, Bureau of Indian Affairs; Arizona Agricultural Experiment Station; and the Gila River Tribe

Soil Survey of Gila River Indian Reservation, Arizona

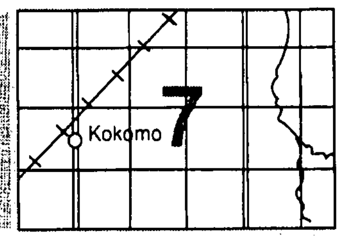
Parts of Maricopa and Pinal Counties

How to Use This Soil Survey

General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

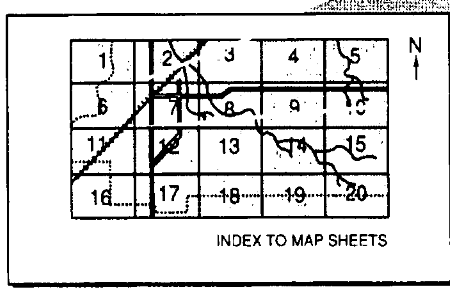
To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.



MAP SHEET

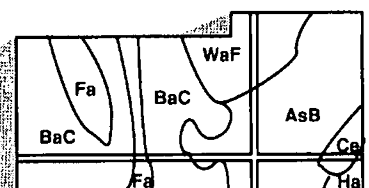
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



INDEX TO MAP SHEETS

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet and turn to that sheet.



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

Locate your area of interest on the map sheet. Note the map units symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

MAP SHEET

The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1991. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. This survey was made cooperatively by the Natural Resources Conservation Service and the Arizona Agricultural Experiment Station. It is part of the technical assistance furnished to the Gila River Natural Resource Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: The Sacaton Mountains on the Gila River Indian Reservation. Quilotosa-Rock outcrop-Vaiva complex, 20 to 65 percent slopes, is on the hills in the background. Brios gravelly loamy sand, 3 to 5 percent slopes, is in the foreground.

Contents

Foreword

This soil survey contains information that can be used in land-planning programs on the Gila River Indian Reservation. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for efficient food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations that affect various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey soils are poorly suited to use as septic tank absorption fields.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

Michael Somerville
State Conservationist
Natural Resources Conservation Service

Soil Survey of Gila River Indian Reservation, Arizona
Parts of Maricopa and Pinal Counties

By William W. Johnson Jr., Philip D. Camp, and John D. Preston

Fieldwork by William W. Johnson Jr., John D. Preston, Philip D. Camp, and Harlan E. Jacoby

United States Department of Agriculture, Natural Resources Conservation Service, and United States Department of the Interior, Bureau of Indian Affairs; in cooperation with the Arizona Agricultural Experiment Station and the Gila River Tribe.

An older survey, "Land Suitability for Irrigated Agriculture," was published in 1969. This earlier survey covers a part of the present survey. The present survey, however, updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

Descriptions, names, and delineations of soils in this survey do not fully agree with those on soil maps for adjacent survey areas. Differences are the result of better knowledge of soils, modifications in series concepts, intensity of mapping, or the extent of soils within the survey.

The adjoining Maricopa County, Arizona, Central Part (1977) and Eastern Maricopa and Northern Pinal Counties Area, Arizona (1974) soil surveys are of such age that classification concepts have changed, and the most practical join has been made.

The Pinal County, Arizona, Western part (1991) soil survey does not fully agree as to named components in the mapping units nor joining of soil boundaries. However, use and management are essentially the same for most soils in the two areas (soils of such an extent as to be named in one soil survey area are of minor extent in the adjoining area and are considered inclusions of similar soils).

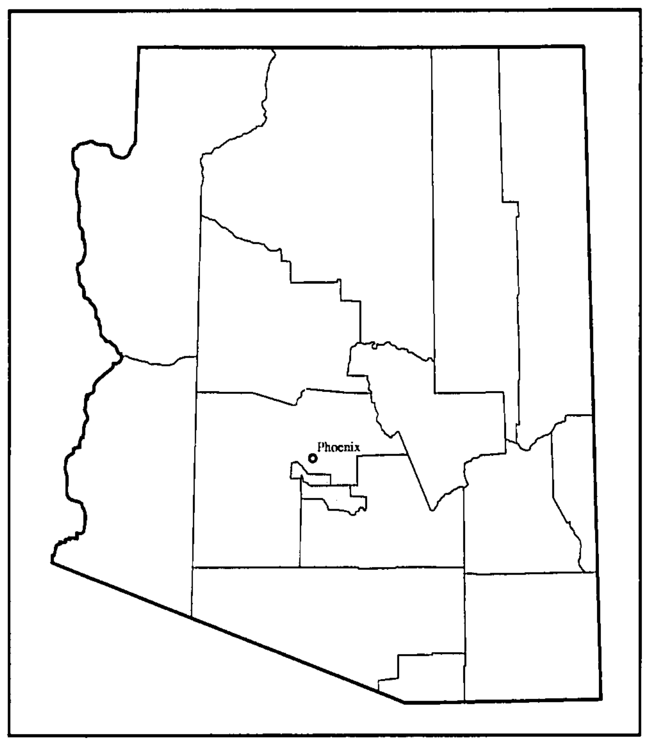


Figure 1.— Location of Gila River Indian Reservation in Arizona.

General Nature of the Survey Area

This section briefly discusses the history and development, transportation, natural resources, and climate of the survey area (fig. 1).

History and Development

Among the early inhabitants of the survey area were the Hohokam, a Piman word for "the ancient ones" or "those who have gone before." These skilled people occupied the Gila River Valley since the beginnings of the Christian era.

The most remarkable accomplishment of the Hohokam people, and one that has left its mark on succeeding generations and cultures, was the engineering and construction of a complex system of irrigation canals. Over 150 miles of canals were constructed between A.D. 700 and 1300. The primary crops of these primitive farmers were maize, beans, melons, and cotton.

About A.D. 1400 the Hohokam disappeared for reasons not yet known. The Spaniards encountered Pima Indians in the area about 1530 but it hasn't been established what took place in the intervening years. The fact that the Pimas were well established supports the belief that the Hohokam were the ancestors of the modern Pima people.

The Pimas are one of two major Indian groups that comprise the Gila River Indian community. During the late 1600's and 1700's these Pima-speaking people extended from the Gila River in the north for 1,000 miles south into Sonora, Mexico. The Sonora Pimas were known as Lower Pimas and were greatly influenced by the missionary activities of the Jesuits. However, Upper Pimas were on the northern frontier of Spanish colonization and did not become a part of the mission system that reached as far north as San Xavier del Bac near Tucson. Although several Spaniards visited the area, any impact remained minimal.

The other major Indian group comprising the Gila River Indian Community is the Maricopas, a Yuman-speaking people who originally lived south of Parker, Arizona, along the Colorado River. During the late 1800's, the Maricopas and other related groups who came to be known by that name began migrating east up the Gila River to avoid hostilities which were flaring between various Yuman-speaking peoples. In 1857, the Pimas joined the Maricopas in defeating a combined force of Mohaves and Yumas. Thereafter, they were permitted to settle in the northwest portion of the reservation (Maricopa Colony) to develop an agricultural community.

The Mexican-American War of 1846-48 and the Gadsden Purchase of 1853 secured this territory for the United States, greatly accelerating subsequent development. In 1859, the U.S. Government appointed agents for the Pimas, and in 1869 built an agency at Sacaton and licensed traders. At this time the reservation's area was increased from 64,000 acres to 145,000 acres. Subsequent Executive Orders (the last being issued in 1915) increased the reservation area to 371,933 acres.

Traditionally, the Gila River people have settled in low-density villages located where water was available for farming (fig. 2). Hence, settlements occurred along both sides of the Gila River and included many now-abandoned sites such as the historically important Snaketown.

In the late 1800's and early 1900's conflict erupted between the Pimas and upriver Anglos and Mexicans who competed for the sparse Gila River water. The Gila River had sustained the agricultural economy of the Pimas, and then the Maricopas, since prehistoric times. This loss of available water led to an economically depressed community and forced many residents off the reservation to make a living *(16)*.

A solution to the water shortages of the community appeared imminent with the construction of Coolidge Dam in 1929 on the San Carlos Apache Indian Reservation. Nevertheless, sporadic drought conditions led to an unpredictable water supply throughout the 1930s and 1940s. In 1951, the Tribal Council established a tribal farm in 1951 which became the forerunner of recent economic development activities in the community. This positive development points to the Gila River people's role as a major agricultural supplier, now and in the future.

Transportation

The Reservation's position between the major population centers in the state, and its proximity to the Phoenix metropolitan area, have made it the site of major transportation corridors.

The most significant thoroughfare is Interstate 10, linking Phoenix and Tucson. The 24-mile corridor through the Reservation bisects the community into east and west halves. Four interchanges (Maricopa Road, Riggs Road, Casa Blanca Road, and Casa Grande Road) provide local access to the freeway.

Four state highways serve the area. Arizona Highway 87 runs southeast to northwest and locally connects Chandler and Coolidge. Arizona Highway 93 runs north and south to the Casa Blanca I-10 interchange.

Arizona Highways 187 and 387 are smaller, two-lane roads. Arizona Highway 187 runs from the Four Mile Post on Arizona Highway 87, west to I-10 at the Casa Grande interchange. Arizona Highway 387 links Arizona Highway 87 at a point near Blackwater School Road with I-10 at the Casa Grande interchange. This two-lane highway passes through the Sacaton Mountains, offering a scenic and more direct route for motorists from Blackwater, Coolidge, Florence, and other areas, and connects with I-10 at the Casa Grande interchange.

Two major Maricopa County Highway Department

Fig. 2.—Fence made from native soil and plant materials. Pillars are made of adobe. Areas between pillars are enclosed by interwoven ocotillo branches. Commonly, these will take root and leaf out following a rainfall.

roads are Maricopa and Riggs Roads. Maricopa Road runs from Chandler to Maricopa and Stanfield in a southwesterly direction. Riggs Road originates east of the Reservation as a section line arterial road and continues west for 10.5 miles where it angles northwest and is commonly called Beltline Highway, which runs into and becomes 51st Avenue at Gila Crossing. The Pinal County Highway Department maintains the southern portion of Maricopa Road and also Gilbert Road, a section line road that runs from Arizona Highway 87.

The remaining 350 miles of the Reservation's roads are maintained by the BIA's Branch of Roads. The most important BIA road is Tribal Route 1, which runs from Arizona Highway 87 at Four Mile Post east of Sacaton, west to Maricopa Road. In addition, Tribal Route 7 runs north and south through Sacaton, south around Agency Peak to Arizona Highway 187. A network of farm and community roads connects most other areas. The Southern Pacific Railroad provides freight service to several industrial parks in the community.

Natural Resources

The soil is a valuable resource on the Gila River Indian Community. Farming, which is directly influenced by soil properties, provides the livelihood of many people. Also, mesquite thickets are a major resource. The Komatke Thicket south of the community of Santa Cruz provides 6,800 acres of mesquite, the only fuel source for an estimated 200 homes.

Climate

Climatic data for this section were prepared especially for the Natural Resources Conservation Service by the National Climatic Data Center, Asheville, North Carolina.

On the Gila River Indian Reservation, summers are hot, especially at lower elevations, and winters are mild. Precipitation is normally light at lower elevations during all months of the year, and land is mainly used for range.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Sacaton, Arizona, for the period 1951 to 1981. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 51 degrees F., and the average daily minimum temperature is 35 degrees. The lowest temperature on record, which occurred at Sacaton on January 6, 1971, is 9 degrees. In summer, the average temperature is 88 degrees, and the average daily maximum temperature is 104 degrees. The highest recorded temperature, which occurred on June 26, 1979, is 118 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 8 inches. Of this, 3 inches, or 40 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 2 inches. The heaviest 1-day rainfall during the period of record was 2.05 inches at Sacaton on April 21, 1955. Thunderstorms occur on about 23 days each year, and most occur in summer.

Snowfall is rare. In 99 percent of the winters, there is no measurable snowfall. In 1 percent, the snowfall, usually of short duration, is less than 1 inch.

The average relative humidity in midafternoon is about 30 percent. Humidity is higher at night, and the average at dawn is about 50 percent. The sun shines 90 percent of the time possible in summer and 75 percent in winter. The prevailing wind is from the east. Average windspeed is highest, 7 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of soil data. The objectives of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The components of one map unit can occur in another but in a different pattern (fig. 3).

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

This general soil map updates an earlier version *(41)*.

Soil Descriptions

1. Gadsden-Brios

Very deep, well drained and excessively drained, nearly level to gently sloping, fine and coarse textured soils on flood plains

Setting

Topography: flood plains
Location: Gila and Salt Rivers and Santa Cruz Wash
Flooding: common
Slope range: 0 to 5 percent
Vegetation: mesquite, saltcedar, arroweed, seepweed, and annual canarygrass
Elevation: 940 to 1,550 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F.
Frost-free period: 240 to 280 days

Composition

Percent of survey area: 14
Gadsden soils: 40 percent
Brios soils: 15 percent
Minor soils: 45 percent

Soil Properties and Qualities

Gadsden

Depth: very deep
Drainage class: well drained
Parent material: clayey stream alluvium
Textural class: fine
Distinctive properties: saline and sodic and finely stratified

Brios

Depth: very deep
Drainage class: excessively drained
Parent material: sandy stream alluvium
Textural class: coarse
Distinctive properties: saline

Minor soils

- Moderately-fine textured Trix, Glenbar and Yahana soils
- Coarse-textured Lagunita and Vint soils

Use and Management

Major use: rangeland

Major management factors: salinity, sodicity and flooding

2. Yahana-Indio

Very deep, well drained, nearly level to strongly sloping, moderately fine and medium textured soils on flood plains

Setting

Topography: flood plains
Location: Gila and Salt Rivers and Santa Cruz Wash

Flooding: rare
Slope range: 0 to 10 percent
Vegetation: seepweed, greasewood, desert saltbush, mesquite, wolfberry
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F.
Frost-free period: 240 to 280 days

Composition

Percent of survey area: 13 percent
- Yahana soils: 35 percent
- Indio soils: 30 percent
- Minor soils: 35 percent

Soil Properties and Qualities

Yahana

Depth: very deep
Drainage class: well drained
Parent material: silty stream alluvium
Textural class: moderately fine
Distinctive properties: extraordinarily saline and sodic

Indio

Depth: very deep
Drainage class: well drained
Parent material: silty stream alluvium
Textural class: medium

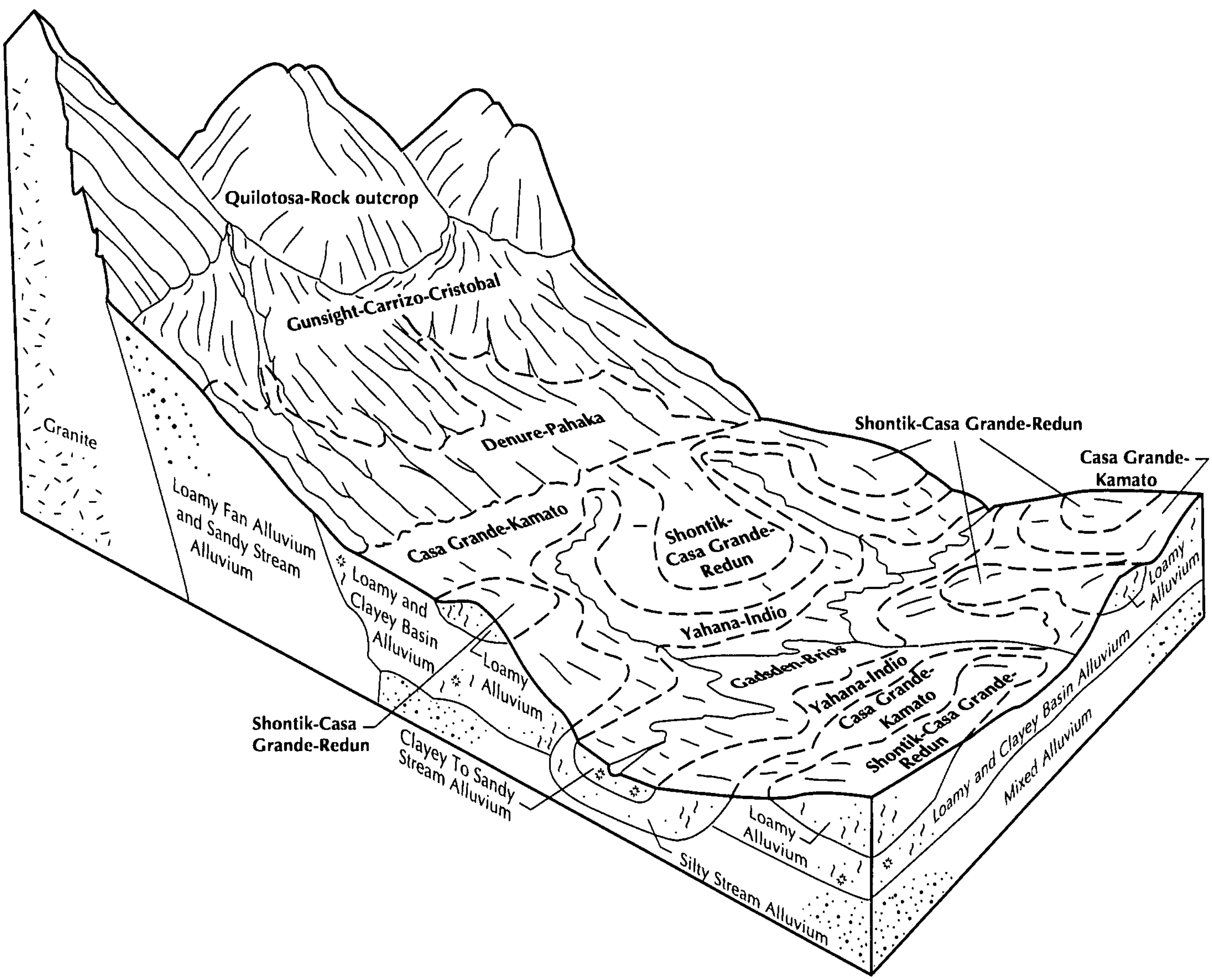


Figure 3.—Typical pattern of soil associations in the survey area.

Distinctive properties: saline and sodic and finely stratified

Minor soils

- Moderately fine textured Glenbar and Trix soils
- Fine textured Gadsden soils
- Coarse textured Vint soils

Use and Management

Major uses: rangeland, irrigated cropland

Major management factors: salinity, sodicity and flooding

3. Denure-Pahaka

Very deep, somewhat excessively drained and well drained, nearly level to gently sloping gravelly moderately coarse and gravelly moderately coarse over gravelly moderately fine textured soils on fan terraces

Setting

Topography: fan terraces
Location: throughout the survey area
Flooding: none
Slope range: 1 to 5 percent
Vegetation: creosotebush, white bursage, triangle bursage, and annual grasses
Elevation: 1,000 to 1,450 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F.
Frost-free period: 240 to 280 days

Composition

Percent of survey area: 10
Denure soils: 45 percent
Pahaka soils: 20 percent
Minor soils: 35 percent

Soil Properties and Qualities

Denure

Depth: very deep
Drainage class: somewhat excessively drained
Parent material: loamy fan alluvium
Textural class: gravelly moderately coarse
Distinctive properties: relatively uniform profile

Pahaka

Depth: very deep
Drainage class: well drained
Parent material: loamy fan alluvium
Textural class: gravelly moderately coarse over gravelly moderately fine
Distinctive properties: buried soil at moderate depths

Minor soils

- Soils with high concentrations of lime—Gunsight and Rillito soils
- Very gravelly moderately coarse textured Momoli soils
- Soils subject to flooding—Brios, Carrizo and Why soils

Use and Management

Major uses: rangeland, irrigated cropland

Major management factors: limited available water capacity

4. Gunsight-Carrizo-Cristobal

Very deep and deep (to a hardpan), well drained to excessively drained, nearly level to rolling, very gravelly coarse to extremely gravelly moderately fine textured soils on fan terraces and flood plains

Setting

Topography: fan terraces and flood plains
Location: adjacent to the Sierra Estrella, Sacaton and Santan Mountains
Flooding: Gunsight & Cristobal—none; Carrizo—none to occasional
Slope range: 1 to 15 percent
Vegetation: creosotebush, cactus and annual grasses
Elevation: 940 to 1,800 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F.
Frost-free period: 240 to 280 days

Composition

Percent of survey area: 10
Gunsight and similar soils: 22 percent
Carrizo soils: 18 percent
Cristobal and similar soils: 15 percent
Minor soils: 45 percent

Soil Properties and Qualities

Gunsight and similar soils

Depth: Very deep
Drainage class: somewhat excessively drained
Parent material: loamy fan alluvium
Textural class: very gravelly moderately coarse

Distinctive properties: very limy layer
Similar soil: Rillito

Carrizo

Depth: very deep
Drainage class: excessively drained
Parent material: sandy stream alluvium and fan alluvium
Textural class: very gravelly coarse
Distinctive properties: stratified

Cristobal and similar soil

Depth: deep (to a hardpan)
Drainage class: well drained
Parent material: loamy fan alluvium
Textural class: extremely gravelly moderately fine
Distinctive properties: weak to moderate desert pavement
Similar soil: Pinamt

Minor soils

- Soils shallow to a hardpan—Cavelt soils
- Soils subject to flooding—Brios and Why soils
- Very gravelly moderately coarse textured Momoli soils
- Saline soils covered with desert pavement—Chuckawalla soils

Use and Management

Major use: rangeland

Major management factors: very limy layer, hazard of flooding, depth to hardpan

5. Casa Grande-Kamato

Very deep, well drained, nearly level to gently sloping, moderately fine and fine textured soils on relict basin floors

Setting

Topography: relict basin floors
Location: north-central part of survey area
Flooding: none (small areas subject to ponding)
Slope range: 0 to 5 percent
Vegetation: desert saltbush, seepweed, wolfberry, and mesquite
Elevation: 950 to 1,200 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F.
Frost-free period: 240 to 280 days

Composition

Percent of survey area: 10
Casa Grande soils: 70 percent
Kamato soils: 18 percent
Minor soils: 12 percent

Soil Properties and Qualities

Casa Grande

Depth: very deep
Drainage class: well drained
Parent material: loamy basin alluvium
Textural class: moderately fine
Distinctive properties: saline and sodic

Kamato

Depth: very deep
Drainage class: well drained
Parent material: clayey basin alluvium
Textural class: fine
Distinctive properties: saline and sodic containing gypsum

Minor soils

- Medium over moderately fine textured Tatai soils
- Moderately coarse over moderately fine textured Shontik soils
- Moderately coarse textured Redun soils
- Soils subject to flooding—Trix and Glenbar soils
- Slickspots

Use and Management

Major use: rangeland, irrigated cropland, urban land

Major management factors: salinity, sodicity, shrink-swell

6. Shontik-Casa Grande-Redun

Very deep, well drained, nearly level to undulating moderately coarse over moderately fine, moderately fine and moderately coarse textured soils on high stream terraces, low fan terraces, and relict basin floors

Setting

Topography: high stream terraces, low fan terraces, and relict basin floors
Location: throughout the survey area
Flooding: none
Slope range: 0 to 5 percent
Vegetation: desert saltbush, linearleaf saltbush, wolfberry, and annuals
Elevation: 950 to 1,250 feet

Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F.
Frost-free period: 240 to 280 days

Composition

Percent of survey area: 26
Shontik soils: 25 percent
Casa Grande soils: 20 percent
Redun soils: 20 percent
Minor soils: 35 percent

Soil Properties and Qualities

Shontik

Depth: very deep
Drainage class: well drained
Parent material: loamy stream alluvium and fan alluvium
Textural class: moderately coarse over moderately fine
Distinctive properties: saline and sodic

Casa Grande

Depth: very deep
Drainage class: well drained
Parent material: loamy basin alluvium
Textural class: moderately fine
Distinctive properties: saline and sodic

Redun

Depth: very deep
Drainage class: well drained
Parent material: loamy stream alluvium and fan alluvium
Textural class: moderately coarse
Distinctive properties: saline and sodic

Minor soils

- Medium textured Dateland, Laveen, and Tatai soils
- Coarse textured Rositas soils
- Soils subject to flooding—Cuerda, Glenbar, and Trix soils
- Slickspots

Use and Management

Major use: rangeland, irrigated cropland, urban land

Major management factors: salinity, sodicity

7. Quilotosa-Rock outcrop

Very shallow and shallow somewhat excessively drained, gently sloping to very steep, extremely gravelly moderately coarse textured soils and Rock outcrop on hills and mountains

Setting

Topography: hills and mountains
Location: Sierra Estrella, Sacaton, and Santan Mountains
Flooding: none
Slope range: 5 to 65 percent
Vegetation: creosotebush, paloverde, brittlebush, cactus, and annuals
Elevation: 1,150 to 3,100 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F.
Frost-free period: 240 to 280 days

Composition

Percent of survey area: 17
Quilotosa soils: 35 percent
Rock outcrop: 15 percent
Minor soils: 50 percent

Soil Properties and Qualities

Quilotosa

Depth: very shallow and shallow
Drainage class: somewhat excessively drained
Parent material: loamy alluvium and colluvium
Textural class: extremely gravelly moderately coarse
Distinctive properties: weathered from granite

Rock outcrop consists of areas of exposed granite and gneiss

Minor soils

- Lomitas and Pompeii soils on basalt hills and mountains
- Moderately fine textured Vaiva soils
- Deep and very deep Cristobal, Gunsight and Momoli soils

Use and Management

Major use: rangeland

Major management factors: depth to rock, slope

Detailed Soil Map Units

The map units delineated on the detailed maps at the back of this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information about each map unit is given under the heading "Use and Management of the Soils."

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Casa Grande fine sandy loam, 0 to 3 percent slopes, is a phase of the Casa Grande series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Chuckawalla-Gunsight complex, 1 to 5 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Gadsden, Glenbar, and Vint soils, saline-sodic, 0 to 2 percent slopes is an undifferentiated group in this survey area.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

Soil Descriptions

1—Brios gravelly loamy sand, 3 to 5 percent slopes

Setting

Landform: alluvial fans
Landscape position: areas where drainageways emerge from hills and mountains onto lower-lying plains
Flooding: occasional
Elevation: 950 to 1,550 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Brios soil and similar soils: 80 percent
Contrasting inclusions: 20 percent

Typical Profile

0 to 2 inches—light yellowish brown gravelly loamy sand
2 to 60 inches—light yellowish brown and very pale brown stratified loamy coarse sand and coarse sand

Soil Properties and Qualities

Parent material: fan alluvium
Depth class: very deep
Drainage class: excessively
Permeability: rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Hazard of water erosion: slight
Hazard of wind erosion: high
Shrink-swell potential: low
Corrosivity: concrete—low; steel—high

Inclusions

Contrasting inclusions:
- Soils that are extremely gravelly (Carrizo)

Similar inclusions:
- Soils that are gravelly sand throughout
- Soils that have surface textures of coarse sandy loam, coarse sand, and gravelly or very gravelly sand

Use and Management

Rangeland

Dominant vegetation:
- Potential plant community—littleleaf paloverde, ironwood, catclaw acacia, bush muhly
- Present plant community—ironwood, white bursage, paloverde, catclaw acacia

Important forage species: bush muhly and big galleta
Major management factors: flooding, droughtiness
General management considerations:
- This unit is among the most productive in the survey area.
- This unit benefits from run-on moisture, which increases the amount of forage produced.
- Livestock movement is hindered by dense brushy growth.
- This unit has shade for livestock.
- Livestock will generally overgraze this area, unless controlled, because of the availability of water and abundance of feed.
- Overgrazing reduces the plant cover and increases the rate of erosion.
- Extra care in management is needed to protect this unit from erosion.

Suitable management practices:
- Thin trees to encourage production of perennial grasses.
- Provide erosion protection if the plant cover is distributed.
- Seeding can be used to improve range condition when there are not enough remnant grasses to reestablish the site.
- Use water-spreading dikes to increase the area that benefits from run-on moisture.

• Prevent overgrazing of this unit by fencing or controlling water availability.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability for desertic riparian herbaceous plants: moderately well suited
Suitability for desertic riparian shrubs and trees: well suited

Interpretive Groups

Land capability classification: VIIw
Range site: Sandy Bottom, 7- to 10-inch precipitation zone

2—Brios very fine sandy loam, 0 to 2 percent slopes

Setting

Landform: flood plains
Landscape position: lowlands adjacent to the Gila River (fig. 4)
Flooding: occasional
Elevation: 1,200 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Brios soil and similar soils: 85 percent
Contrasting inclusions: 15 percent

Figure 4.—A typical area of Brios very fine sandy loam, 0 to 2 percent slopes. Sediment and debris have accumulated around shrubs following recent flooding.

Typical Profile

0 to 6 inches—light yellowish brown stratified very fine sandy loam
6 to 19 inches—pale brown stratified gravelly coarse sandy loam
19 to 31 inches—pale brown stratified fine sand and silt loam
31 to 60 inches—pale brown stratified sand and gravelly coarse sand

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: excessively drained
Permeability: rapid
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Shrink-swell potential: low
Corrosivity: concrete—low; steel—high
Salinity—slight
Sodicity—slight

Inclusions

Contrasting inclusions:
• Soils that are very gravelly or cobbly (Carrizo).
• Soils with finer textures (Glenbar, Gadsden).
Similar inclusions:
• Soils that are dominantly fine sand or loamy fine sand (Vint).
• Soils with surface textures of sandy loam, sand or loamy sand.

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—paloverde, ironwood, wolfberry, bush muhly, and big galleta
• Present plant community—mesquite, saltcedar, narrowleaf fourwing saltbush
Important forage species: bush muhly and big galleta.
Major management factors: flooding, droughtiness
General management considerations:
• This unit is among the most productive in the survey area.
• This unit benefits from run-on moisture, which increases the amount of forage produced.
• Livestock movement is hindered by dense brushy growth.
• This unit has shade for livestock.
• Livestock will generally overgraze this area, unless controlled, because of the availability of water and abundance of feed.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
Suitable management practices:
• Thin trees to encourage production of perennial grasses.
• Provide erosion protection if the plant cover is disturbed.
• Seeding can be used to improve range condition when there are not enough remnant perennial grasses to reestablish the site.
• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Prevent overgrazing of this unit by fencing or controlling water availability.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability for riparian herbaceous plants and riparian shrubs and trees: well suited

Interpretive Groups

Land capability classification: IVw irrigated, VIIw nonirrigated
Range site: Sandy Bottom, 7- to 10-inch precipitation zone

3—Carrizo-Momoli complex, 1 to 3 percent slopes

Setting

Landform: fan terraces
Landscape position: Momoli—slightly elevated uplands between drainageways; Carrizo—slightly lower areas adjacent to the Momoli soil
Flooding: none
Slope range: 1 to 3 percent
Elevation: 1,100 to 1,800 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Carrizo soil and similar soils: 60 percent
Momoli soil and similar soils: 25 percent
Contrasting inclusions: 15 percent

Typical Profile

Carrizo

0 to 5 inches—light yellowish brown gravelly sandy loam
5 to 16 inches—reddish yellow very gravelly loam
16 to 44 inches—light brown extremely cobbly loamy sand
44 to 60 inches—pale brown very cobbly sand

Momoli

0 to 4 inches—light yellowish brown extremely gravelly sandy loam
4 to 10 inches—light yellowish brown extremely gravelly sandy loam
10 to 41 inches—pale brown extremely gravelly sandy loam
41 to 60 inches—pink extremely gravelly sandy loam

Soil Properties and Qualities

Carrizo

Parent material: fan alluvium
Depth class: very deep
Drainage class: excessively drained
Permeability: very rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Momoli

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
• Soils in washes (Carrizo, flooded phase, and Why).
• Rock outcrop.
Similar inclusions:
• Soils similar to Momoli but having less gravel (Denure).
• Areas of slopes ranging to 5 percent.
• Soils that have surface textures of very gravelly sandy loam, loam or fine sandy loam, extremely gravelly sandy loam, and loam.

Use and Management

Rangeland

Dominant vegetation on the Carrizo soil:
• Potential plant community—creosotebush, white ratany, triangle bursage
• Present plant community—creosotebush, triangle bursage, ironwood, paloverde
Dominant vegetation on the Momoli soil:
• Potential plant community—creosotebush, white ratany, triangle bursage
• Present plant community—creosotebush, triangle bursage, ironwood, paloverde
Important forage species: winter-spring annuals
Major management factors: coarse textures, rock fragments, droughtiness
General management considerations on the Carrizo and Momoli soils:
• This unit is among the least productive in the survey area.
• Potential vegetation is dominated by desert shrubs.
• The majority of forage is produced on included soils along the drainageways.
• Production on this site is limited by the high lime content of the soils.
• This unit is easily traversed by livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
Suitable management practices on the Carrizo and Momoli soils:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, coarse textures, rock fragments
General management considerations:
• Most climatically suited crops can be grown on this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• Leveling cuts will expose sand and gravel.

• Water can be distributed by concrete-lined ditches or pipelines.
Suitable management practices:
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Farming on the contour or across the slope, where practical, reduces runoff and helps control water erosion.
• Irrigation water can be applied efficiently by using sprinkler, drip, border, or furrow irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field to a basin system may be prohibitive. A graded system is more feasible in those areas.
• To avoid overirrigating and leaching of plant nutrients and to reduce the risk of water erosion, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop's needs.
• Line irrigation ditches with concrete or install pipelines to reduce loss of water seepage.
• The condition of the soil is maintained or improved by returning crop residue to the soil and by keeping tillage to a minimum.
• The risk of flooding from included soils in small drainageways can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability of the Carrizo and Momoli soils for desertic, herbaceous plants and desertic shrubs and trees: poorly suited

Interpretive Groups

Land capability classification:
Carrizo soil—IVs irrigated, VIIs nonirrigated
Momoli soil—IIIs irrigated, VIIs nonirrigated
Range site:
Carrizo soil—Limy Upland (deep), 7- to 10-inch precipitation zone
Momoli soil—Limy Upland (deep), 7- to 10-inch precipitation zone

4—Carrizo-Pinamt complex, 1 to 5 percent slopes

Setting

Landform: fan terraces
Landscape position: Carrizo—slightly elevated uplands adjacent to drainageways; Pinamt—slightly elevated uplands between drainageways
Flooding: none
Slope range: 1 to 5 percent
Elevation: 1,100 to 1,800 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Carrizo soil and similar soils: 50 percent
Pinamt soil and similar soils: 35 percent
Contrasting inclusions: 15 percent

Typical Profile

Carrizo

0 to 5 inches—light yellowish brown gravelly sandy loam
5 to 16 inches—reddish yellow very gravelly loam
16 to 44 inches—light brown extremely cobbly loamy sand
44 to 60 inches—pale brown very cobbly sand

Pinamt

0 to 3 inches—light yellowish brown very gravelly loam
3 to 8 inches—red extremely gravelly sandy clay loam
8 to 36 inches—reddish yellow cobbly coarse sandy loam and extremely gravelly loamy coarse sand
36 to 60 inches—light yellowish brown extremely gravelly coarse sand

Soil Properties and Qualities

Carrizo

Parent material: fan alluvium
Depth class: very deep
Drainage class: excessively drained
Permeability: very rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Pinamt

Parent material: fan alluvium
Depth class: very deep
Drainage class: well
Permeability: moderately slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Depth to a limy layer: 20 to 40 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight

Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
• Soils in washes (Carrizo, flooded phase)
• Exposure of hardpan in drainageways
• Soils that are less sandy and gravelly (Denure, Momoli)
• Soils that are saline and sodic at the distal end of the fan terraces
Similar inclusions:
• Areas of slopes ranging to 15 percent
• Soils that have surface textures of sandy loam, very gravelly and extremely gravelly loam and sandy loam, and very gravelly loamy sand

Use and Management

Rangeland

Dominant vegetation on the Carrizo soil:
• Potential plant community—creosotebush, white ratany, triangle bursage
• Present plant community—creosotebush, triangle bursage, ironwood, paloverde, cactus
Dominant vegetation on the Pinamt soil:
• Potential plant community—creosotebush, triangle bursage, white ratany
• Present plant community—creosotebush, triangle bursage, ironwood, paloverde, cactus
Important forage species: winter-spring annuals
Major management factors: droughtiness
General management considerations on the Carrizo and Pinamt soils:
• This unit is among the least productive in the survey area.
• Potential vegetation is dominated by desert shrubs.
• The majority of forage is produced on included soils along the drainageways.
• Production on this site is limited by the high lime content of the soils.
• This unit is easily traversed by livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
Suitable management practices on the Carrizo and Pinamt soils:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Carrizo and Pinamt soils for desertic herbaceous plants and desertic shrubs and trees: poorly suited

Interpretive Groups

Land capability classification:
Carrizo soil—VIIs nonirrigated
Pinamt soil—VIIs nonirrigated
Range site:
Carrizo soil— Limy Upland (deep), 7- to 10-inch precipitation zone
Pinamt soil—Limy Upland (deep), 7- to 10-inch precipitation zone

5—Carrizo very gravelly coarse sand, 0 to 1 percent slopes

Setting

Landform: flood plains
Landscape position: narrow washes
Flooding: occasional
Elevation: 940 to 1,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Carrizo soil and similar soils: 90 percent
Contrasting inclusions: 10 percent

Typical Profile

0 to 52 inches—light yellowish brown very gravelly coarse sand
52 to 60 inches—strong brown very gravelly loamy coarse sand

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: excessively
Permeability: very rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Hazard of water erosion: very slight
Hazard of wind erosion: very slight
Shrink-swell potential: low
Corrosivity: concrete—low; steel—high

Inclusions

Contrasting inclusions:
- Finer textured soils (Why).
- Soils having large amounts of cobbles and stones.

Similar inclusions:
- Soils having less gravel (Brios).
- Soils that are noncalcareous throughout.

Use and Management

Rangeland

Dominant vegetation:
- Potential plant community—blue paloverde, littleleaf paloverde, ironwood, bush muhly
- Present plant community—ironwood, paloverde, wolfberry, triangle bursage

Important forage species: bush muhly and big galleta
Major management factors: flooding, coarse textures
General management considerations:
- This unit is among the most productive in the survey area.
- Potential vegetation is dominated by perennial grasses, desert shrubs, and trees.
- This unit benefits from run-on moisture, which increases the amount of forage produced.
- Livestock movement is hindered by dense brushy growth.
- This unit has shade for livestock.
- Livestock will generally overgraze this area, unless controlled, because of the availability of water and abundance of feed.
- Overgrazing reduces the plant cover and increases the rate of erosion.
- Extra care in management is needed to protect this unit from erosion.

Suitable management practices:
- Thin trees to encourage production of perennial grasses.
- Provide erosion protection if the plant cover is disturbed.
- Seeding can be used to improve range condition when not enough remnant perennial grasses are present to reestablish the site.
- Use water-spreading dikes to increase the area that benefits from run-on moisture.
- Prevent overgrazing of this unit by fencing or controlling water availability.
- Control erosion and promote forage production with proper utilization.
- Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability for desertic riparian herbaceous plants and desertic riparian shrubs and trees: well suited

Interpretive Groups

Land capability classification: VIIw, nonirrigated
Range site: Sandy Bottom, 7- to 10-inch precipitation zone

6—Casa Grande clay loam, 0 to 1 percent slopes

Setting

Landform: relict basin floor
Landscape position: swales on broad uplands
Flooding: none
Elevation: 950 to 1,150 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Casa Grande soil and similar soils: 80 percent
Contrasting inclusions: 20 percent

Typical Profile

0 to 15 inches—dark brown, saline and sodic, clay loam
15 to 25 inches—brown, saline and sodic, clay loam
25 to 60 inches—brown, strongly calcareous, loam and clay loam

Soil Properties and Qualities

Parent material: basin alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: moderate
Salinity: strong
Sodicity: strong
Depth to a limy layer: 20 to 40 inches
Corrosivity: concrete—high; steel—high
Hazard of water erosion: slight
Hazard of wind erosion: moderate

Inclusions

Contrasting inclusions:
- Coarser textured soils (Denure).

Similar inclusions:
• Soils similar to Casa Grande that have a very limy layer.
• Area of slopes ranging to 2 percent.
• Soils that receive extra run-on moisture from surrounding areas and tailwater from adjacent irrigated cropland.
• Soils that have surface textures of fine sandy loam, loam, silt loam, and silty clay loam.
• Soils that do not have accumulations of lime.

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, mesquite, Anderson wolfberry
• Present plant community—mesquite, seepweed, wolfberry, desert saltbush
Important forage species: evergreen saltbush browse
Major management factors: salinity, sodicity
General management considerations:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• This unit is easily traversed by livestock.
• This unit has shade for livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. Use soil tests to determine the proper kind and amount of amendments needed.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling made.

Building Site Development

Major management factors: shrink-swell, salinity, sodicity, corrosion hazard, slow permeability
General management considerations:
• The quality of roadbeds and road surfaces can be adversely affected by shrinking and swelling.
• Septic tank absorption fields can be expected to function poorly because of limited permeability, which restricts the movement and filtration of the effluent.
• Preserve as many salt- and sodium-tolerant plants as possible during construction.
Suitable management practices:
• Reduce the risk of erosion and the maintenance cost by stabilizing areas that have been disturbed.
• Prevent structural damage that results from shrinking and swelling by allowing for it in designing and building foundations, concrete structures, and paved areas.
• Offset the risk of corrosion to uncoated steel and concrete by using treated steel pipe and sulphate-resistant cement.
• Compensate for the restricted permeability by increasing the size of the absorption field and backfilling the trench with porous material.
• Select salt- and sodium-tolerant plants for landscaping.

Wildlife Habitat

Suitability for desertic herbaceous plants: poorly suited
Suitability for desertic shrubs and trees: well suited
Suitability for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification: IIs irrigated VIIs nonirrigated
Range site: Saline Loam, 7- to 10-inch precipitation zone

7—Casa Grande complex, 0 to 5 percent slopes

Setting

Landform: relict basin floor
Landscape position: Casa Grande clay loam—nearly level, playa-like depressions; Casa Grande fine sandy loam—undulating uplands (fig. 5)
Flooding: Casa Grande clay loam—ponds water for short periods of time; Casa Grande fine sandy loam—none
Slope range: Casa Grande clay loam—0 to 1 percent; Casa Grande fine sandy loam—1 to 5 percent
Elevation: 950 to 1,150 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Casa Grande clay loam and similar soils: 50 percent
Casa Grande fine sandy loam and similar soils: 35 percent
Contrasting inclusions: 15 percent

Typical Profile

Casa Grande clay loam

0 to 10 inches—light yellowish brown and brown, saline and sodic clay loam
10 to 60 inches—yellowish red, saline and sodic, sandy clay loam

Casa Grande fine sandy loam

0 to 8 inches—light yellowish brown, saline and sodic, fine sandy loam
8 to 40 inches—light brown and reddish brown, saline and sodic, clay loam
40 to 60 inches—light brown, saline and sodic, sandy loam

Soil Properties and Qualities

Casa Grande clay loam

Parent material: basin alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: moderate
Depth to a limy layer: 20 to 40 inches
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Casa Grande fine sandy loam

Parent material: basin alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow

Figure 5.—A typical area of Casa Grande complex, 0 to 5 percent slopes.

Shrink-swell potential: moderate
Depth to a limy layer: 20 to 40 inches
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Clayey soils (Kamato).
• Soils on sand dunes (Rositas).
• Soils with 1- to 3-foot gullies along escarpments.
• Areas of gravelly and very gravelly surfaces.
• Areas underlain by hardpan in an area north of Firebird Lake.
Similar inclusions:
• Soils that are irrigated in the San Carlos irrigation district and have dark brown loam or clay loam surface layers ranging in thickness from 5 to 15 inches.
• Soils that have surface textures of sandy loam, loam, very fine sandy loam, silt loam, silty clay loam, sandy clay loam, and fine sand.
• Areas of slopes ranging to 10 percent.
• Soils that do not have accumulations of lime.

Use and Management

Rangeland

Dominant vegetation on the Casa Grande clay loam soil:
• Potential plant community—Torrey seepweed, thinleaf fourwing saltbush, iodinebush
• Present plant community—barren
Dominant vegetation on the Casa Grande fine sandy loam soil:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, Torrey wolfberry
• Present plant community—seepweed, desert saltbush, thinleaf fourwing saltbush, wolfberry
Important forage species: evergreen saltbush browse
Major management factors: hazard of ponding, salinity and sodicity, droughtiness
General management considerations on the Casa Grande clay loam soil:
• This soil is among the least productive in the survey area.

• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this soil is limited by saline-sodic conditions.
• This unit is easily traversed by livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from further erosion.
• Avoid grazing this soil during the spring because of the availability of black greasewood, a plant toxic to livestock.
• Salt is generally not needed on this soil because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices on the Casa Grande clay loam soil:
• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

General management considerations on the Casa Grande fine sandy loam soil:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this soil is limited by saline-sodic conditions.
• This soil is easily traversed by livestock.
• This soil has shade for livestock.
• Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from erosion.
• Salt is generally not needed on this soil because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices on the Casa Grande fine sandy loam soil:
• Encourage uniform grazing on this soil by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity; hazard of wind erosion (Casa Grande fine sandy loam)

General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation. Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.

Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kinds and amounts of amendments needed should be determined by soil tests.
• To prevent recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.

• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.

Building Site Development:

Major management factors: shrink-swell, salinity, sodicity, corrosion hazard, slow permeability
General management considerations:
• The quality of roadbeds and road surfaces can be adversely affected by shrinking and swelling.
• Septic tank absorption fields can be expected to function poorly because of limited permeability, which restricts the movement and filtration of the effluent.
• Preserve as many salt- and sodium-tolerant plants as possible during construction.
Suitable management practices:
• Reduce the risk of erosion and the maintenance cost by stabilizing areas that have been disturbed.
• Prevent structural damage that results from shrinking and swelling by allowing for it in designing and building foundations, concrete structures, and paved areas.
• Offset the risk of corrosion to uncoated steel and concrete by using treated steel pipe and sulphate-resistant cement.
• Compensate for the restricted permeability by increasing the size of the absorption field and backfilling the trench with porous material.
• Select salt- and sodium-tolerant plants for landscaping.

Wildlife Habitat

Suitability of the Casa Grande clay loam soil for desertic herbaceous plants and desertic shrubs and trees: very poorly suited
Suitability for irrigated grain and seed crops and irrigated grasses and legumes: poorly suited
Suitability of the Casa Grande fine sandy loam soil for desertic herbaceous plants and desertic shrubs and trees: moderately well suited
Suitability for irrigated grain and seed crops and irrigated grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification:
Casa Grande clay loam soil—IIs irrigated, VIIe nonirrigated
Casa Grande fine sandy loam soil—IIs irrigated, VIIe nonirrigated
Range site:
Casa Grande clay loam soil—Alkali Flat, 7- to 10-inch precipitation zone
Casa Grande fine sandy loam soil—Saline Loam, 7- to 10-inch precipitation zone

8—Casa Grande fine sandy loam, 0 to 3 percent slopes

Setting

Landform: relict basin floor
Landscape position: undulating broad uplands (fig. 6)
Flooding: none
Elevation: 950 to 1,150 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Casa Grande soil and similar soils: 80 percent
Contrasting inclusions: 20 percent

Typical Profile

0 to 5 inches—light yellowish brown and pale brown, saline and sodic, fine sandy loam
5 to 11 inches—light yellowish brown, saline and sodic, sandy clay loam
11 to 39 inches—strong brown and brown, saline and sodic, clay loam
39 to 60 inches—light yellowish brown and light brown saline and sodic, sandy clay loam

Soil Properties and Qualities

Parent material: basin alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Depth to a limy layer: 20 to 40 inches
Runoff: slow
Hazard of water erosion: slight
Hazard of wind erosion: moderately high

Salinity: strong
Sodicity: strong
Shrink-swell potential: moderate
Corrosivity: concrete—high; steel—high

Inclusions

Contrasting inclusions:
- Soils on sand dunes (Rositas).
- Coarser soils (Denure, Shontik).
- Clayey soils (Kamato).
- Slickspots that pond water.
- Soils in drainageways (Why).

Similar inclusions:
- Areas of slopes ranging to 8 percent.
- Soils that are irrigated in the San Carlos irrigation district and have dark brown loam or clay loam surface layers ranging in thickness from 5 to 15 inches.
- Soils that have surface textures of loamy fine sand, sandy loam, very fine sandy loam, or sandy clay loam.
- Soils that do not have accumulations of lime.

Use and Management

Rangeland

Dominant vegetation:
- Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, Torrey wolfberry
- Present plant community—seepweed, desert saltbush, thinleaf fourwing, saltbush, wolfberry

Important forage species: evergreen saltbush browse
Major management factors: droughtiness, salinity, sodicity
General management considerations:

Figure 6.—A typical area of Casa Grande fine sandy loam, 0 to 3 percent slopes. Desert saltbush (atriplex polycarpa) is the dominant shrub.

• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• This unit is easily traversed by livestock.
• This unit has shade for livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent water.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, hazard of wind erosion

General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation. Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.

Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentration in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, drip, border, or furrow irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field to a basin system may be prohibitive. A graded system is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.

Building Site Development

Major management factors: shrink-swell, salinity, sodicity, corrosion hazard, slow permeability

General management considerations:
• The quality of roadbeds and road surfaces can be adversely affected by shrinking and swelling.
• Septic tank absorption fields can be expected to function poorly because of limited permeability, which restricts the movement and filtration of the effluent.
• Preserve as many salt- and sodium-tolerant plants as possible during construction.

Suitable management practices:
• Reduce the risk of erosion and the maintenance cost by stabilizing areas that have been disturbed.
• Prevent structural damage that results from shrinking and swelling by allowing for it in designing and building foundations, concrete structures, and paved areas.
• Offset the risk of corrosion to uncoated steel and concrete by using treated steel pipe and sulphate-resistant cement.

• Compensate for the restricted permeability by increasing the size of the absorption field and backfilling the trench with porous material.
• Select salt- and sodium-tolerant plants for landscaping.

Wildlife Habitat

Suitability for desertic, herbaceous plants and desertic shrubs and trees: moderately well suited
Suitability for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification: IIs irrigated, VIIs nonirrigated
Range site: Saline Loam, 7- to 10-inch precipitation zone

9—Cavelt-Carrizo-Gunsight complex, 1 to 10 percent slopes

Setting

Landform: Cavelt and Gunsight—fan terraces; Carrizo—flood plains
Landscape position: Cavelt—broad nearly level uplands between drainageways; Carrizo—areas adjacent to and in drainageways; Gunsight—sideslopes
Flooding: Cavelt and Gunsight—none; Carrizo—occasional
Slope range: Cavelt and Gunsight—1 to 10 percent; Carrizo—1 to 3 percent
Elevation: 950 to 1,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Cavelt soil and similar soils: 35 percent
Carrizo soil and similar soils: 25 percent
Gunsight soil and similar soils: 20 percent
Contrasting inclusions: 20 percent

Typical Profile

Cavelt

0 to 1 inch—light brown, very gravelly loam
1 to 8 inches—pink, strongly calcareous, gravelly loam
8 to 17 inches—white, strongly calcareous, strongly cemented, sandy loam
17 to 24 inches—white indurated, lime-cemented hardpan

Carrizo

0 to 39 inches—pale brown very gravelly coarse sand
39 to 60 inches—light brown very gravelly loamy coarse sand

Gunsight

0 to 1 inch—light yellowish brown very gravelly sandy loam
1 to 20 inches—very pale brown, strongly calcareous, very gravelly sandy loam and coarse sandy loam
20 to 30 inches—light yellowish brown, extremely gravelly coarse sandy loam
30 to 60 inches—very pale brown, strongly calcareous, gravelly coarse sandy loam

Soil Properties and Qualities

Cavelt

Parent material: fan alluvium
Depth class: shallow (to a hardpan)
Drainage class: somewhat excessively
Permeability: moderate
Available water capacity: very low
Potential rooting depth: less than 20 inches
Runoff: moderate
Shrink-swell potential: low
Depth to a lime-cemented hardpan: 10 to 20 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Carrizo

Parent material: fan alluvium
Depth class: very deep
Drainage class: excessively
Permeability: very rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Gunsight

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Depth to a limy layer: less than 20 inches

Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
• Deep coarse textured soils (Carrizo).
• Deep soils that have less than 35 percent rock fragments (Denure).
• Finer textured soils along drainageways (Why).
• Exposures of hardpans on terrace side slopes and in channels.
Similar inclusions:
• Areas of slopes ranging to 40 percent; to near vertical adjacent to drainageways.
• Areas that have discontinuous hardpans.
• Areas that have thick silica caps on the hardpans.
• Soils that are similar to Cavelt and have more than 35 percent rock fragments.
• Soils that have surface textures of gravelly loam and coarse sandy loam and cobbly coarse sandy loam.

Use and Management

Rangeland

Dominant vegetation on the Cavelt soil:
• Potential plant community—creosotebush, triangle bursage, white bursage
• Present plant community—creosotebush, paloverde, bursage, ironwood, ocotillo
Dominant vegetation on the Gunsight soil:
• Potential plant community—creosotebush, triangle bursage, white bursage
• Present plant community—creosotebush, paloverde, bursage, ironwood, ocotillo
Dominant vegetation on the Carrizo soil:
• Potential plant community—littleleaf paloverde, ironwood, big galleta
• Present plant community—white bursage, paloverde, ironwood
Important forage species: Cavelt and Gunsight—winter and spring annuals; Carrizo—bush muhly and big galleta
Major management factors: depth to a hardpan, coarse textures, droughtiness, flooding
General management considerations on the Cavelt and Gunsight soils:
• These soils are among the least productive in the survey area.
• Potential vegetation is dominated by desert shrubs.
• The majority of forage is produced on Carrizo soil along the drainageways.
• Production on these soils is limited by the high lime content.
• These soils are easily traversed by livestock.
• Proper grazing distribution is difficult on these soils because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
Suitable management practices on the Cavelt and Gunsight soils:
• Encourage uniform grazing on these soils by developing and controlling permanent waters.
• Concentrate management on Carrizo soils in the drainageways where the majority of forage is produced.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.
General management considerations on the Carrizo soil:
• This soil is among the most productive in the survey area.
• Potential vegetation is dominated by perennial grasses, desert shrubs, and trees.
• This soil benefits from run-on moisture, which increases the amount of forage produced.
• This soil has shade for livestock.
• Livestock will generally overgraze this soil, unless controlled, because of the availability of water and abundance of feed.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from erosion.
Suitable management practices on the Carrizo soil:
• Thin trees to encourage production of perennial grasses.
• Provide erosion protection if the plant cover is disturbed.
• Seeding can be used to improve range condition when there are not enough remnant perennial grasses to reestablish the site.
• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Prevent overgrazing of this soil by fencing or controlling water availability.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Cavelt soil for desertic herbaceous plants: very poorly suited
Suitability for desertic shrubs and trees: poorly suited
Suitability for the Gunsight soil for desertic herbaceous plants: poorly suited

Suitability for desertic shrubs and trees: moderately well suited
Suitability of the Carrizo soil for desertic riparian herbaceous plants: moderately well suited
Suitability for desertic riparian shrubs and trees: well suited

Interpretive Groups

Land capability classification:
Cavelt soil—VIIs nonirrigated
Gunsight soil—VIIs nonirrigated
Carrizo soil—VIIw nonirrigated
Range site:
Cavelt soil—Limy Upland, 7- to 10-inch precipitation zone
Carrizo soil—Sandy Bottom, 7- to 10-inch precipitation zone
Gunsight soil—Limy Upland (deep), 7- to 10-inch precipitation zone

10—Chuckawalla-Gunsight complex, 1 to 5 percent slopes

Setting

Landform: fan terraces
Landscape position: Chuckawalla—slightly elevated uplands between drainageways; Gunsight—slightly elevated uplands adjacent to drainageways
Flooding: none
Slope range: 1 to 5 percent
Elevation: 1,100 to 1,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Chuckawalla soil and similar soils: 65 percent
Gunsight soil and similar soils: 15 percent
Contrasting inclusions: 20 percent

Typical Profile

Chuckawalla

0 to 2 inches—pink extremely gravelly loam
2 to 10 inches—reddish yellow saline very gravelly loam
10 to 57 inches—pinkish white, strongly calcareous, saline extremely gravelly sandy loam
57 to 60 inches—white, strongly calcareous, very gravelly sand

Gunsight

0 to 1 inch—reddish yellow very gravelly loam
1 to 46 inches—light brown and very pale brown, strongly calcareous, gravelly and very gravelly sandy loam
46 to 60 inches—pale brown, strongly calcareous, very gravelly sand

Soil Properties and Qualities

Chuckawalla

Parent material: fan alluvium
Depth class: very deep
Drainage class: well
Permeability: moderate
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: rapid
Shrink-swell potential: low
Depth to a limy layer: less than 20 inches
Corrosivity: steel—high; concrete—moderate
Hazard of water erosion: slight
Hazard of wind erosion: very slight
Salinity: strong

Gunsight

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Depth to a limy layer: less than 20 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
• Soils in drainageways (Carrizo, Why).
• Soils with less gravel (Denure).
Similar inclusions:
• Soils that have surface textures of gravelly loam and gravelly, very gravelly and extremely gravelly sandy loam.
• Areas of slopes ranging to 8 percent. Some areas adjacent to drainageways range to 40 percent.
• Chuckawalla soils that are noncalcareous in the surface layer.

Use and Management

Rangeland

Dominant vegetation on the Chuckawalla soil:
• Potential plant community—turkshead

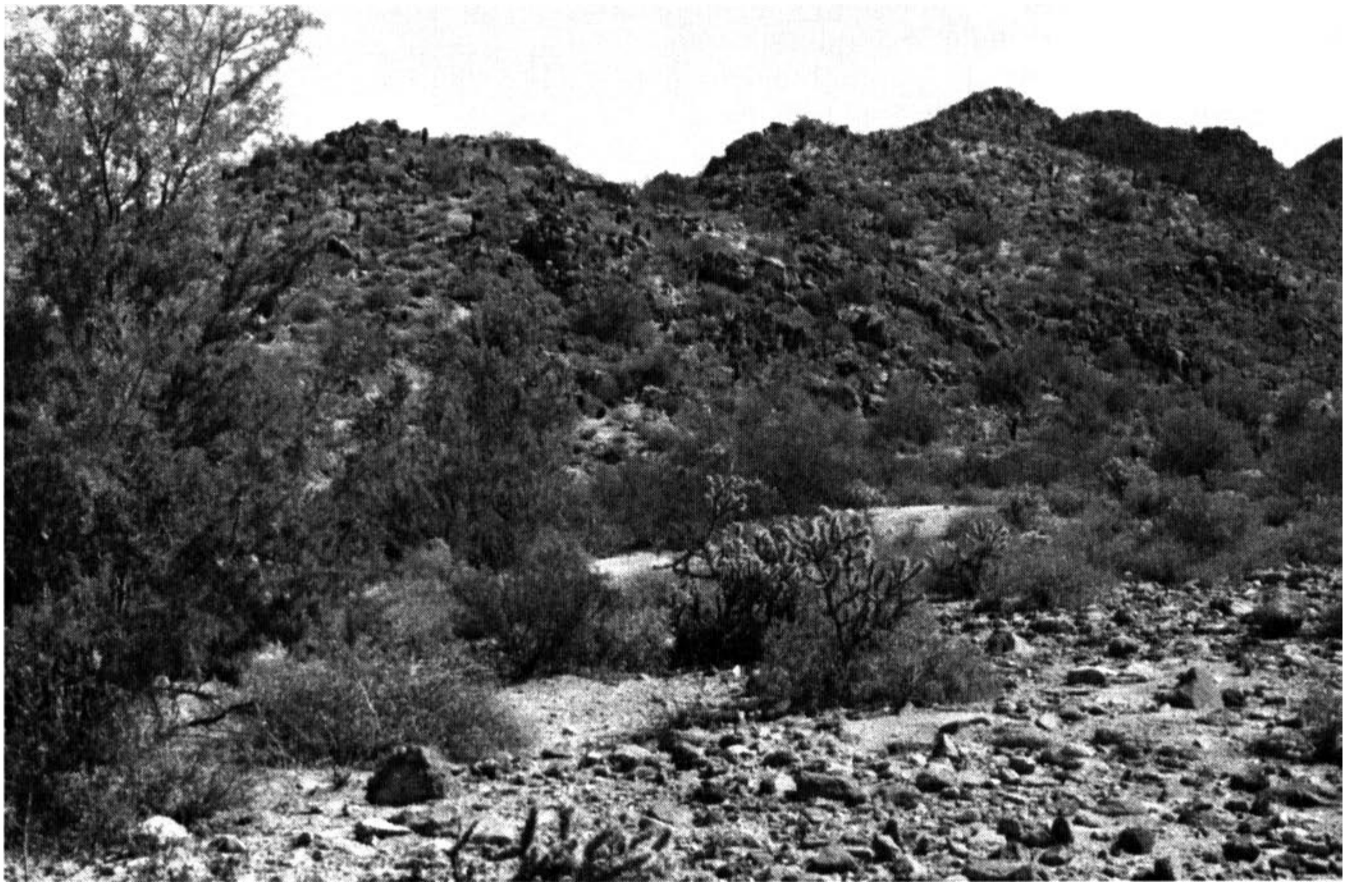


Figure 7.—Foreground shows an area of Cristobal-Gunsight complex, 3 to 15 percent slopes. Background shows Quilotosa-Rock outcrop-Vaiva complex, 20 to 65 percent slopes.

- Present plant community—turkshead

Dominant vegetation on the Gunsight soil:

- Potential plant community—creosotebush, triangle bursage, white bursage
- Present plant community—creosotebush, triangle bursage

Important forage species: winter-spring annuals

Major management factors: salinity, droughtiness, very limy layer

General management considerations on the Chuckawalla-Gunsight soils:

- This unit is among the least productive in the survey area.
- Potential vegetation is dominated by desert shrubs.
- The majority of forage is produced on included soils along the drainageways.
- Production on this site is limited by the high lime content in the Gunsight soils and desert pavement on the Chuckawalla soils.
- This unit is easily traversed by livestock.
- Proper grazing distribution is difficult on this unit because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increases the rate of erosion.

Suitable management practices on the Chuckawalla-Gunsight soils:

- Encourage uniform grazing on this unit by developing and controlling permanent waters.
- Concentrate management on included soils in the drainageways where the majority of forage is produced.
- Control erosion and promote forage production with proper utilization.
- Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Chuckawalla and Gunsight soils for desertic herbaceous plants and desertic shrubs and trees: poorly suited

Interpretive Groups

Land capability classification:
Chuckawalla soil—VIIs nonirrigated
Gunsight soil—VIIs nonirrigated
Range site:
Chuckawalla soil—no range site assigned
Gunsight soil—Limy Upland, (deep), 7- to 10-inch precipitation zone

11—Cristobal-Gunsight complex, 3 to 15 percent slopes

Setting

Landform: fan terraces
Landscape position: Cristobal—slightly elevated uplands between drainageways; Gunsight—slightly elevated uplands adjacent to drainageways (fig. 7)
Flooding: none
Slope range: 3 to 15 percent
Elevation: 1,100 to 1,800 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Cristobal soil and similar soils: 50 percent
Gunsight soil and similar soils: 30 percent
Contrasting inclusions: 20 percent

Typical Profile

Cristobal

0 to 1 inch—reddish yellow very gravelly loam
1 to 41 inches—reddish yellow, yellowish red and red very gravelly and extremely gravelly sandy clay loam
41 to 60 inches—pinkish white silica-lime cemented hardpan

Gunsight

0 to 1 inch—light yellowish brown very gravelly sandy loam
1 to 17 inches—light yellowish brown very gravelly sandy loam
17 to 60 inches—very pale brown, strongly calcareous, extremely gravelly sandy loam

Soil Properties and Qualities

Cristobal

Parent material: fan alluvium
Depth class: deep (to a hardpan)
Drainage class: well
Permeability: moderately slow
Available water capacity: very low
Potential rooting depth: 40 or more inches
Runoff: moderate
Shrink-swell potential: low
Depth to a limy layer: more than 40 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Gunsight

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderate
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Depth to a limy layer: less than 20 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
- Strongly saline soils covered by desert pavement (Chuckawalla).
- Coarse textured soils in washes (Carrizo).
- Exposures of hardpan in drainageways.
- Rock outcrop.
- Areas of slopes ranging from 1 to 20 percent; to near vertical adjacent to drainageways.

Similar inclusions:
- Soils similar to Gunsight but having less lime (Momoli).
- Soils that have surface textures of cobbly loam, sandy loam or sandy clay loam, extremely gravelly sandy loam, and loam.

Use and Management

Rangeland

Dominant vegetation on the Cristobal soil:
- Potential plant community—creosotebush, triangle bursage, white ratany
- Present plant community—creosotebush, triangle bursage, paloverde, ironwood, cactus

Dominant vegetation on the Gunsight soil:
- Potential plant community—creosotebush, triangle bursage, white bursage
- Present plant community—creosotebush, triangle bursage, paloverde, ironwood, cactus

Important forage species: winter-spring annuals

Major management factors: depth to a hardpan, rock fragments, droughtiness, very limy layer
General management considerations on the Cristobal-Gunsight soils:
• This unit is among the least productive in the survey area.
• Potential vegetation is dominated by desert shrubs.
• The majority of forage is produced on included soils along the drainageways.
• Production on this site is limited by the high lime content in the soils.
• This unit is easily traversed by livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
Suitable management practices on the Cristobal-Gunsight soils:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Cristobal and Gunsight soils for desertic herbaceous plants: poorly suited
Suitability for the Cristobal and Gunsight soils for desertic shrubs and trees: moderately well suited

Interpretive Groups

Land capability classification:
Cristobal soil—VIIs nonirrigated
Gunsight soil—VIIs nonirrigated
Range site:
Cristobal soil—Limy Upland, (deep) 7- to 10-inch precipitation zone
Gunsight soil—Limy Upland, (deep) 7- to 10-inch precipitation zone

12—Dateland-Cuerda complex, saline-sodic, 0 to 3 percent slopes

Setting

Landform: Dateland—fan terraces, Cuerda—flood plains
Landscape position: Dateland—undulating uplands; Cuerda—areas adjacent to and in drainageways
Flooding: Dateland—none; Cuerda—occasional
Slope range: 0 to 3 percent
Elevation: 900 to 1,200 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Dateland soil and similar soils: 50 percent
Cuerda soil and similar soils: 30 percent
Contrasting inclusions: 20 percent

Typical Profile

Dateland

0 to 10 inches—very pale brown, saline and sodic, fine sandy loam
10 to 60 inches—reddish yellow and strong brown, saline and sodic, loam

Cuerda

0 to 3 inches—light brown stratified very fine sandy loam
3 to 6 inches—light brown stratified fine sandy loam
6 to 60 inches—reddish yellow, saline and sodic, loam

Soil Properties and Qualities

Dateland

Parent material: fan alluvium
Depth class: very deep
Drainage class: well
Permeability: moderate
Available water capacity: moderate
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Depth to a limy layer: few lime masses lower part
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: moderate to strong
Sodicity: strong

Cuerda

Parent material: fan alluvium
Depth class: very deep
Drainage class: well
Permeability: moderate
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Depth to a limy layer: few lime masses lower part
Corrosivity: steel—high; concrete—high
Hazard of water erosion: moderate

Hazard of wind ersosion: moderate
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Soils with sand or gravelly sand at moderate depths.
• Moderately fine textured soils (Casa Grande, Trix).
• Moderately coarse textured soils over moderately fine textured subsoils (Shontik).
Similar inclusions:
• Moderately coarse textured soils (Denure, Why).
• Soils that are on alluvial fans at the distal end of the map unit and are subject to occasional brief periods of flooding.

Use and Management

Rangeland

Dominant vegetation on the Dateland soil:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, wolfberry, annual grasses
• Present plant community—desert saltbush, annual grasses, wolfberry
Dominant vegetation on the Cuerda soil:
• Potential plant community—mesquite, alkali sacaton, Anderson wolfberry, desert saltbush, fourwing saltbush
• Present plant community—mesquite, wolfberry, desert saltbush
Important forage species: evergreen saltbush browse
Major management factors: salinity, sodicity, droughtiness, flooding
General management considerations on the Dateland soil:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this soil is limited by saline-sodic conditions.
• This soil is easily traversed by livestock.
• This soil has shade for livestock.
• The production on this soil is limited by saline-sodic conditions.
• Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from erosion.
• Salt is generally not needed on this soil because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices on the Dateland soil:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.
General management considerations on the Cuerda soil:
• This soil is among the most productive in the survey area.
• Potential vegetation is dominated by a mixture of salt-tolerant grasses and shrubs.
• Important perennial forage potentially includes alkali sacaton, twoflower trichloris, and inland saltgrass.
• This soil benefits from run-on moisture which increases the amount of forage produced.
• Livestock movement is hindered by dense brushy growth.
• This soil has shade for livestock.
• Livestock will generally overgraze this soil unless controlled, because of the availability of water and abundance of feed.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from erosion.
• Salt is generally not needed on this soil because the available browse contains salt.
Suitable management practices on the Cuerda soil:
• Thin trees to encourage production of perennial grasses.
• Provide erosion protection if the plant cover is disturbed.
• Seeding can be used to improve range condition when there are not enough remnant perennial grasses to reestablish the site.
• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Prevent overgrazing of this soil by fencing or controlling water availability.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, hazard of wind erosion (Dateland); flooding, hazard of water erosion (Cuerda)
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.

• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The included soils on alluvial fans are subject to sheet flooding during prolonged high intensity storms. Where unprotected cropland adjoins these areas the cropland is subject to flooding and erosion.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.

Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• The risk of flooding can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability of the Dateland soil for desertic herbaceous plants and desertic shrubs and trees: poorly suited
Suitability of the Dateland soil for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited
Suitability of the Cuerda soil for desertic riparian herbaceous plants and desertic riparian shrubs and trees: moderately well suited
Suitability of the Cuerda soil for irrigated grain and seed crops and irrigated grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification:
Dateland soil—IIs irrigated, VIIs nonirrigated
Cuerda soil—IIw irrigated, VIIw nonirrigated
Range site:
Dateland soil—Saline Loam, 7- to 10-inch precipitation zone
Cuerda soil—Saline Bottom, 7- to 10-inch precipitation zone

13—Denure-Pahaka complex, 1 to 3 percent slopes

Setting

Landform: fan terraces
Landscape position: broad undulating uplands bordering mountains (fig. 8)
Flooding: none
Slope range: 1 to 3 percent
Elevation: 1,000 to 1,250 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Denure soil and similar soils: 55 percent
Pahaka soil and similar soils: 25 percent
Contrasting inclusions: 20 percent

Typical Profile

Denure
0 to 3 inches—light yellowish brown and light brown gravelly coarse sandy loam

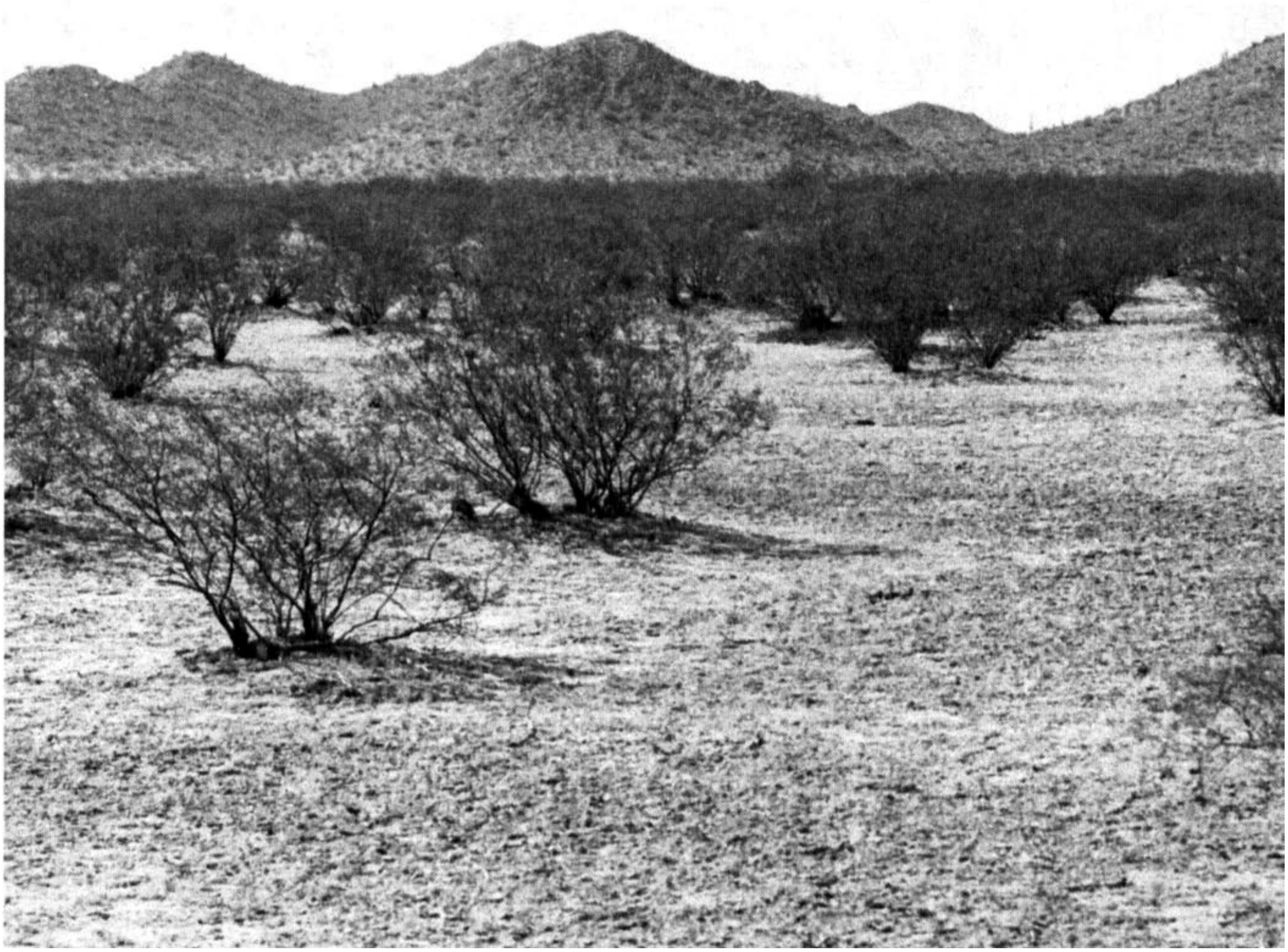


Figure 8.—A typical area of Denure-Pahaka complex, 1 to 3 percent slopes. Creosotebush (Larrea divaricata) is the dominant shrub. Quilotosa-Rock outcrop-Vaiva complex, 20 to 65 percent slopes, occurs on the hills in the background.

3 to 49 inches—reddish yellow gravelly coarse sandy loam
49 to 60 inches—reddish yellow very gravelly coarse sandy loam

Pahaka

0 to 9 inches—light yellowish brown and reddish yellow loam and fine sandy loam
9 to 34 inches—reddish yellow fine sandy loam and gravelly sandy loam
34 to 46 inches—yellowish red very gravelly sandy clay loam
46 to 60 inches—pink, strongly cemented, gravelly sandy clay loam

Soil Properties and Qualities

Denure

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: moderate
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Depth to a limy layer: few lime masses lower part
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: moderately high

Pahaka

Parent material: fan alluvium
Depth class: very deep
Drainage class: well
Permeability: moderately rapid—upper part, moderately slow—lower part
Available water capacity: moderate
Potential rooting depth: 60 or more inches

Runoff: slow
Shrink-swell potential: low—upper part; moderate—lower part
Depth to a limy layer: more than 40 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: nonsaline to slight in the upper part; moderate in the lower part
Sodicity: slight in the upper part; moderate in the lower part

Inclusions

Contrasting inclusions:
• Soils that have hardpans (Cavelt).
• Soils that have very limy layers (Rillito).
• Sandy soils (Brios).
• Very gravelly soils (Momoli).
Similar inclusions:
• Soils with slopes ranging to 5 percent.
• Soils that have surface textures of sand or sandy loam.
• Soils in swales and drainageways (Why).
• Soils that are on alluvial fans at the distal end of the map unit and are subject to occasional brief periods of flooding.

Use and Management

Rangeland

Dominant vegetation on the Denure-Pahaka soils:
• Potential plant community—creosotebush, triangle bursage, white bursage, big galleta, bush muhly
• Present plant community—creosotebush, white bursage, triangle bursage
Important forage species: winter-spring annuals
Major management factors: droughtiness
General management considerations on the Denure and Pahaka soils:
• This unit among the least productive in the survey area.
• Potential vegetation is dominated by desert shrubs.
• The majority of forage is produced on included soils along the drainageways.
• Production on this site is limited by the high lime content in the soils.
• This unit is easily traversed by livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
• A few areas are noncalcareous in the surface layer and are therefore more productive.
Suitable management practices on the Denure-Pahaka soils:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor an production.

Cropland

Major management factors: droughtiness, hazard of wind erosion
General management considerations:
• Most climatically suited crops can be grown on this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• Leveling cuts of 20 to 40 inches generally will expose a buried clay loam or sandy clay loam subsoil. In some areas, this subsoil contains concentrations of lime.
• Water can be distributed by concrete-lined ditches or pipelines.
• The included soils on alluvial fans are subject to sheet flooding during prolonged high intensity storms. Where unprotected cropland adjoins these areas the cropland is subject to flooding and erosion.
Suitable management practices:
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Irrigating across the slope, where practical, reduces runoff and helps to control erosion.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• To avoid overirrigating and leaching of plant nutrients and to reduce the risk of water erosion, application of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop's needs.
• Line irrigation ditches with concrete or install pipelines to reduce loss of water by seepage.
• The soil condition is maintained or improved by returning crop residue and by keeping tillage to a minimum.
• Keeping the soil rough and cloddy when it is not

protected by vegetation or crop residue helps reduce wind erosion.
• The risk of flooding of included soils can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability of the Denure and Pahaka soils for desertic herbaceous plants and desertic shrubs and trees: poorly suited
Suitability of the Denure and Pahaka soils for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification:
Denure soil—IIIs irrigated, VIIs nonirrigated
Pahaka soil—I irrigated, VIIc nonirrigated
Range site:
Denure soil—Limy Fan, 7- to 10-inch precipitation zone
Pahaka soil—Limy Fan, 7- to 10-inch precipitation zone

14—Denure-Pahaka complex, 3 to 5 percent slopes

Setting

Landform: fan terraces
Landscape position: broad undulating uplands bordering mountains
Flooding: none
Slope range: 3 to 5 percent
Elevation: 1,100 to 1,450 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Denure soil and similar soils: 40 percent
Pahaka soil and similar soils: 25 percent
Contrasting inclusions: 35 percent

Typical Profile

Denure

0 to 2 inches—brownish yellow very gravelly fine sandy loam
2 to 47 inches—brownish yellow and very pale brown fine sandy loam and sandy loam
47 to 60 inches—strong brown very gravelly sandy loam

Pahaka

0 to 1 inch—light brown very gravelly fine sandy loam
1 to 17 inches—reddish yellow gravelly loam
17 to 30 inches—brown and reddish yellow fine sandy loam
30 to 60 inches—reddish brown and pink gravelly clay loam and very gravelly sandy clay loam

Soil Properties and Qualities

Denure

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Depth to a limy layer: few lime masses lower part
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Pahaka

Parent material: fan alluvium
Depth class: very deep
Drainage class: well
Permeability: moderately rapid—upper part (above 30 inches), moderately slow—lower part (below 30 inches)
Available water capacity: moderate
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low—upper part, moderate—lower part
Depth to a limy layer: more than 40 inches
Corrosivity: steel—high; concrete—low
• Hazard of water erosion: moderate
• Hazard of wind erosion: slight
Salinity: nonsaline to slight in the upper part; moderate in the lower part
Sodicity: moderate

Inclusions

Contrasting inclusions:
• Soils that are saline and sodic at the distal end of the mapping unit.
• Soils along drainageways (Brios, Carrizo, Why).
• Soils that have very limy layers (Rillito).
• Soils that have more gravel (Momoli).
• Strongly saline soils covered by desert pavement (Chuckawalla).
Similar inclusions:
• Soils that have surface textures of gravelly, very gravelly and extremely gravelly sandy loam, and gravelly fine sandy loam.

• Soils that are non-effervescent to depths of 6 or 8 inches.
• Areas of slopes ranging to 7 percent. Some areas adjacent to drainageways range to 25 percent.

Use and Management

Rangeland

Dominant vegetation on the Denure soil:
• Potential plant community—creosotebush, triangle bursage, white bursage
• Present plant community—creosotebush, triangle bursage
Dominant vegetation on the Pahaka soil:
• Potential plant community—creosotebush, triangle bursage, white bursage
• Present plant community—creosotebush, triangle bursage
Important forage species: winter-spring annuals
Major management factors: droughtiness
General management considerations on the Denure-Pahaka soils:
• This unit is among the least productive in the survey area.
• Potential vegetation is dominated by desert shrubs.
• The majority of forage is produced on included soils along the drainageways.
• Production on this site is limited by the high lime content in the soils.
• This unit is easily traversed by livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices on the Denure-Pahaka soils:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Denure-Pahaka soil for desertic herbaceous plants and desertic shrubs and trees: moderately well suited

Interpretive Groups

Land capability classification:
Denure soil—IIIs irrigated, VIIs nonirrigated
Pahaka soil—IIs irrigated, VIIs nonirrigated
Range site:
Denure soil—Limy Fan, 7- to 10-inch precipitation zone
Pahaka soil—Limy Fan, 7- to 10-inch precipitation zone

15—Gadsden, Glenbar and Vint soils, saline-sodic, 0 to 2 percent slopes

Setting

Landform: flood plains
Landscape position: areas within the Gila River (fig. 9)
Flooding: occasional
Slope range: 0 to 2 percent
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Gadsden soil and similar soils: variable percentage
Glenbar soil and similar soils: variable percentage
Vint soil and similar soils: variable percentage
Contrasting inclusions: variable percentage

Typical Profile

Gadsden

0 to 5 inches—light brown and light yellowish brown, saline and sodic, silty clay loam
5 to 60 inches—light brown, stratified saline and sodic, silty clay and silty clay loam

Glenbar

0 to 3 inches—pale brown, saline and sodic, silt loam
3 to 60 inches—light yellowish brown and yellowish brown, stratified saline and sodic, silt loam and silty clay loam

Vint

0 to 43 inches—pale brown and light brownish gray, stratified saline, loamy fine sand and fine sand with thin strata of finer soil
43 to 60 inches—brown and pale brown stratified saline silty clay and very fine sandy loam with thin strata of coarser soil

Soil Properties and Qualities

Gadsden

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: high
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Glenbar

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: moderately slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: moderate
Corrosivity: steel—high; concrete—high
Hazard of water erosion: moderate

Figure 9.—Gila River channel in an area of Gadsden, Glenbar, and Vint soils, saline-sodic, 0 to 2 percent slopes.

Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Vint

Parent material: stream alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—moderate
Hazard of water erosion: severe
Hazard of wind erosion: severe
Salinity: moderate to strong

Inclusions

Contrasting inclusions:
• Very gravelly sandy soils (Carrizo).
Similar inclusions:
• Soils similar to Glenbar with less clay (Indio).

Use and Management

Rangeland

Dominant vegetation on the Gadsden soil:
• Potential plant community—mesquite, alkali sacaton, inland saltgrass
• Present plant community—mesquite, saltcedar, canarygrass, desert saltbush, wolfberry, screwbean mesquite, seepweed
Dominant vegetation on the Glenbar soil:
• Potential plant community—alkali sacaton, desert saltbush, mesquite
• Present plant community—mesquite, saltcedar, desert saltbush, wolfberry, screwbean mesquite, seepweed
Dominant vegetation on the Vint soil:
• Potential plant community—desert saltbush, mesquite, fourwing saltbush
• Present plant community—mesquite, saltcedar, desert saltbush, wolfberry, screwbean mesquite, seepweed
Important forage species: alkali sacaton, twoflower trichloris and inland saltgrass
Major management factors: flooding, salinity, sodicity, hazard of water erosion
General management considerations on the Gadsden, Glenbar and Vint soils:
• This unit is among the most productive in the survey area.
• Potential vegetation is dominated by a mixture of salt-tolerant grasses and shrubs.
• This unit benefits from run-on moisture, which increases the amount of forage produced.
• Livestock movement is hindered by dense brushy growth.
• This unit has shade for livestock.
• Livestock will generally overgraze this area, unless controlled, because of the availability of water and abundance of feed.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
Suitable management practices on the Gadsden, Glenbar, and Vint soils:
• Thin trees to encourage production of perennial grasses.
• Provide erosion protection if the plant cover is disturbed.
• Seeding can be used to improve range condition when there are not enough remnant perennial grasses to reestablish the site.
• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Prevent overgrazing of this unit by fencing or controlling water availability.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Gadsden, Glenbar and Vint soils for desertic riparian herbaceous plants and riparian shrubs and trees: well suited

Interpretive Groups

Land capability classification:
Gadsden soil—VIIw nonirrigated
Glenbar soil—VIIw nonirrigated
Vint soil—VIIw nonirrigated
Range site:
Gadsen soil—Saline Bottom, 7- to 10-inch precipitation zone
Glenbar soil—Saline Bottom, 7- to 10-inch precipitation zone
Vint soil—Saline Bottom, 7- to 10-inch precipitation zone

16—Gadsden silty clay loam, saline-sodic, 0 to 2 percent slopes

Setting

Landform: flood plains
Landscape position: lowlands adjacent to the Gila River and its tributaries
Flooding: rare
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Gadsden soil and similar soils: 80 percent
Contrasting inclusions: 20 percent

Typical Profile

0 to 2 inches—pale brown, silty clay loam
2 to 60 inches—light yellowish brown, brown and pale brown stratified saline and sodic silty clay

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: well drained
Permeability: slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Shrink-swell potential: high
Corrosivity: concrete—moderate; steel—high
Salinity: moderate to strong
Sodicity: moderate

Inclusions

Contrasting inclusions:
• Soils that have very strongly saline horizons (Yahana).
• Soils that have silty clay loam over sand at moderate depths.
• Gullied areas as much as 4 feet deep.
Similar inclusions:
• Soils that have surface layers of very fine sandy loam or silt loam.
• Soils that are moderately fine textured (Glenbar).

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, mesquite, Anderson wolfberry, Torrey wolfberry
• Present plant community—desert saltbush, thinleaf fourwing saltbush, Torrey wolfberry, Anderson wolfberry, mesquite
Important forage species: evergreen saltbush browse
Major management factors: flooding, salinity, sodicity
General management considerations:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic conditions.
• This unit is easily traversed by livestock.
• This unit has shade for livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, slow permeability
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are

recommended to provide better estimates of the available water capacity.

Suitable management practices:

• Salt-tolerant crops should be selected for planting during reclamation.

• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.

• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.

• To prevent recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.

• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.

• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.

• Irrigation water can be applied efficiently by using trickle or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.

• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.

• Line ditches with concrete or install pipelines to eliminate loss of water.

• The risk of flooding can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability for desertic riparian herbaceous plants and desertic riparian shrubs and trees: poorly suited
Suitability for irrigated domestic grasses and legumes and irrigated grain and seed crops: poorly suited

Interpretive Groups

Land capability classification: IIIs irrigated, VIIs nonirrigated
Range site: Saline Loam, 7- to 10-inch precipitation zone

17—Glenbar silt loam, saline-sodic, 0 to 2 percent slopes

Setting

Landform: flood plains
Landscape position: lowlands adjacent to the Gila River and its tributaries
Flooding: rare to occasional
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Glenbar soil and similar soils: 70 percent
Contrasting inclusions: 30 percent

Typical Profile

0 to 4 inches—brown, stratified saline and sodic, silt loam
4 to 60 inches—brown, pale brown and grayish brown, stratified saline and sodic silty clay loam and silt loam

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: well drained
Permeability: moderately slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: moderate
Corrosivity: concrete—high; steel—high
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:

• Soils that are fine textured (Gadsden).

• Soils that have very strongly saline horizons (Yahana).

• Soils that have sand over silty clay loam or clay at moderate depths.

• Soils that have silty clay loam over sand at moderate depths.

• Gullied areas as much as 4 feet deep.

Similar inclusions:

• Soils that have surface layers of very fine sandy loam or silty clay loam.

• Soils that are silt loam throughout (Indio).

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—mesquite, desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, Torrey wolfberry
• Present plant community—desert saltbush, thinleaf fourwing saltbush, Torrey wolfberry, Anderson wolfberry, mesquite
Important forage species: evergreen saltbush browse
Major management factors: flooding, salinity, sodicity
General management considerations:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• This unit is easily traversed by livestock.
• This unit has shade for livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, flooding
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type 5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• The risk of flooding can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability for desertic riparian herbaceous plants and desertic riparian shrubs and trees: poorly suited

Suitability for irrigated grain and seed crops and irrigated domestic grasses and legumes: poorly suited

Interpretive Groups

Land capability classification: IIs irrigated, VIIs nonirrigated
Range site: Saline Loam, 7- to 10-inch precipitation zone

18—Indio silt loam, saline-sodic, 0 to 2 percent slopes

Setting

Landform: flood plains
Landscape position: lowlands adjacent to the Gila River and its tributaries
Flooding: rare
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Indio soil and similar soils: 75 percent
Contrasting inclusions: 25 percent

Typical Profile

0 to 3 inches—pale brown, saline and sodic, silt loam
3 to 60 inches—light yellowish brown and pale brown, stratified, saline and sodic, silt loam

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: moderately slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Hazard of water erosion: slight
Hazard of wind erosion: moderate
Shrink-swell potential: low
Corrosivity: concrete—high; steel—high
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Areas of 4-foot deep gullies.
• Soils that are finer textured (Glenbar).
• Slickspots.
• Soils that are moderately deep to sand.

Similar inclusions:
• Soils that have slopes of up to 5 percent.
• Soils that have surface textures of very fine sandy loam or loamy fine sand.

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—thinleaf fourwing saltbush, desert saltbush, Torrey seepweed, Anderson wolfberry
• Present plant community—fourwing saltbush, desert saltbush, Torrey seepweed, wolfberry, scattered mesquite
Important forage species: evergreen saltbush browse
Major management factors: flooding, salinity, sodicity
General management considerations:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• This unit is easily traversed by livestock.
• This unit has shade for livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, flooding
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.

• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.

Suitable management practices:

• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kinds and amounts of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• The risk of flooding can be reduced by the use of dikes and diversions.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling made.

Wildlife Habitat

Suitability for desertic riparian herbaceous plants and desertic riparian shrubs and trees: poorly suited
Suitability for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification: IIs irrigated, VIIs nonirrigated
Range site: Saline Loam, 7- to 10-inch precipitation zone

19—Indio-Vint complex, saline-sodic, 0 to 3 percent slopes

Setting

Landform: flood plains
Landscape position: Indio—lowlands adjacent to the Gila River; Vint—sand splays on lowlands adjacent to the Gila River
Flooding: rare
Slope range: 0 to 3 percent
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Indio soil and similar soils: 50 percent
Vint soil and similar soils: 20 percent
Contrasting inclusions: 30 percent

Typical Profile

Indio

0 to 3 inches—pale brown, saline and sodic, silt loam
3 to 60 inches—light yellowish brown and pale brown, stratified saline and sodic, silt loam

Vint

0 to 10 inches—brown fine sandy loam
10 to 43 inches—brown stratified saline and sodic, loamy fine sand
43 to 60 inches—pale brown stratified saline and sodic, very fine sandy loam

Soil Properties and Qualities

Indio

Parent material: stream alluvium
Depth class: very deep

Drainage class: well
Permeability: moderately slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—high
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Vint

Parent material: stream alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—moderate
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: moderate
Sodicity: strong

Inclusions

Contrasting inclusions:
- Slickspots that pond water.
- Soils underlain by sand at moderate depths.
- Finer textured soils (Gadsden, Glenbar)
- Soils with very strongly saline strata (Yahana).
- Areas of 1- to 4-foot deep gullies.

Similar inclusions:
- Hung channels that run parallel to the Gila River.
- Soils that are very fine sandy loam throughout.
- Soils that have surface textures of very fine sand, fine sand, loamy very fine sand, very fine sandy loam, loam, fine sandy loam, and silty clay loam.
- Areas that have slopes ranging from 10 percent to near vertical near the Gila River.

Use and Management

Rangeland

Dominant vegetation on the Indio soil:
- Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, Torrey wolfberry
- Present plant community—seepweed, desert saltbush, scattered mesquite, wolfberry

Dominant vegetation on the Vint soil:
- Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry
- Present plant community—desert saltbush, thinleaf fourwing saltbush, mesquite, annuals

Important forage species: evergreen saltbush browse
Major management factors: flooding, salinity, sodicity
General management considerations on the Indio soil:
- Potential vegetation is dominated by salt-tolerant shrubs.
- Production on this soil is limited by saline-sodic conditions.
- This soil is easily traversed by livestock.
- This soil has shade for livestock.
- Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increases the rate of erosion.
- Extra care in management is needed to protect this soil from erosion.
- Salt is generally not needed on this soil because the available browse contains salt.
- When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices on the Indio soil:
- Encourage uniform grazing on this soil by developing and controlling permanent waters.
- Provide a protein supplement when annuals are not available.
- Control erosion and promote forage production with proper utilization.
- Provide periodic rest during the growing season to maintain plant vigor and production.

General management considerations on the Vint soil:
- Potential vegetation is dominated by salt-tolerant shrubs.
- This soil is easily traversed by livestock.
- Production on this soil is limited by saline-sodic conditions.
- Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increasess the rate of erosion.
- Salt is generally not needed on this soil because the available browse contains salt.
- When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices on the Vint soil:
- Encourage uniform grazing on this soil by developing and controlling permanent waters.
- Prevent overgrazing of this unit by fencing or controlling water availability.
- Improve distribution and utilization by concentrating a higher number of livestock on the area for a short period of time.

• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity; hazard of wind erosion (Vint)
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid germination in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of the amendment needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• The risk of flooding can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability of the Indio and Vint soils for desertic herbaceous plants: moderately well suited
Suitability of the Indio and Vint soils for desertic shrubs and trees: poorly suited
Suitability for the Indio soil for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited
Suitability of the Vint soil for irrigated grain and seed crops and irrigated domestic grasses and legumes: poorly suited

Interpretive Groups

Land capability classification:
Indio soil—IIs irrigated, VIIs nonirrigated
Vint soil—IIIs irrigated, VIIs nonirrigated
Range site:
Indio soil—Saline Loam, 7- to 10-inch precipitation zone
Vint soil—Saline Sandy Loam, 7- to 10-inch precipitation zone

20—Kamato complex, 0 to 5 percent slopes

Setting

Landform: relict basin floor
Landscape position: Kamato fine sandy loam—undulating uplands; Kamato clay loam—nearly level playa-like depressions
Flooding: Kamato fine sandy loam—none; Kamato clay loam—ponds water for short periods
Slope range: Kamato fine sandy loam—1 to 5 percent; Kamato clay loam—0 to 1 percent
Elevation: 950 to 1,150 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Kamato fine sandy loam soil and similar soils: 40 percent
Kamato clay loam soil and similar soils: 40 percent
Contrasting inclusions: 20 percent

Typical Profile

Kamato fine sandy loam

0 to 6 inches—light yellowish brown, sodic, fine sandy loam
6 to 11 inches—strong brown, saline and sodic, loam
11 to 60 inches—reddish brown, saline and sodic, clay and clay loam

Kamato clay loam

0 to 11 inches—light reddish brown clay loam
11 to 60 inches—reddish brown clay and clay loam

Soil Properties and Qualities

Kamato fine sandy loam

Parent material: basin alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: high
Depth to a limy layer: 20 to 40 inches
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: strong
Sodicity: strong

Kamato clay loam

Parent material: basin alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: high
Depth to a limy layer: 20 to 40 inches
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
- Moderately coarse textured soils (Denure).
- Moderately coarse textured soils over a moderately fine textured buried subsoil (Shontik).
- Medium textured soils over a moderately fine textured subsoil (Tatai).
- Heavily vegetated areas formerly receiving extra run-on moisture principally from the old RWCD floodway in the vicinity of the intersection of State Routes 87 and 587. These areas have lower salinity-sodicity levels because of leaching.

Similar inclusions:
- Soils that have surface textures of loam.
- Soils with less clay (Casa Grande)
- Soils that do not have accumulations of lime.

Use and Management

Rangeland

Dominant vegetation on the Kamato fine sandy loam soil:
- Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry
- Present plant community—desert saltbush, thinleaf fourwing saltbush, wolfberry, seepweed, mesquite

Dominant vegetation on the Kamato clay loam soil:
- Potential plant community—thinleaf fourwing saltbush, Torrey seepweed, black greasewood
- Present plant community—barren

Important forage species: evergreen saltbush browse
Major management factors: salinity, sodicity, droughtiness, ponding
General management considerations on the Kamato fine sandy loam soil:
- Potential vegetation is dominated by salt-tolerant shrubs.
- Production on this soil is limited by saline-sodic soils.
- This soil is easily traversed by livestock.
- This soil has shade for livestock.
- Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increases the rate of erosion.
- Extra care in management is needed to protect this soil from erosion.
- Salt is generally not needed on this soil because the available browse contains salt.
- When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices on the Kamato fine sandy loam soil:

• Encourage uniform grazing on this soil by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

General management considerations on the Kamato clay loam soil:

• This soil is among the least productive in the survey area.
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this soil is limited by saline-sodic conditions.
• This soil is easily traversed by livestock.
• Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from further erosion.
• Salt is generally not needed on this soil because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
• Avoid grazing this soil during the spring because of the availability of black greasewood, a plant toxic to livestock.

Suitable management practices on the Kamato clay loam soil:

• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Encourage uniform grazing on this soil by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity; slope and hazard of wind erosion (Kamato fine sandy loam)

General management considerations:

• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.

Suitable management practices:

• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using trickle or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.

Wildlife Habitat

Suitability of the Kamato fine sandy loam soil for desertic herbaceous plants and desertic shrubs and trees: moderately well suited
Suitability of the Kamato clay loam soil for desertic herbaceous plants and desertic shrubs and trees: very poorly suited
Suitability of the Kamato soils for irrigated grain and seed crops and irrigated domestic grasses and legumes: poorly suited

Interpretive Groups

Land capability classification:
Kamato fine sandy loam soil—IIs irrigated, VIIs nonirrigated
Kamato clay loam soil—IIIe irrigated, VIIe nonirrigated
Range site:
Kamato fine sandy loam soil—Saline Loam, 7- to 10-inch precipitation zone
Kamato clay loam soil—Alkali Flat, 7- to 10-inch precipitation zone

21—Kamato loam, 0 to 2 percent slopes

Setting

Landform: relict basin floor
Landscape position: undulating broad uplands
Flooding: none
Elevation: 950 to 1,150 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Kamato soil and similar soils: 75 percent
Contrasting inclusions: 25 percent

Typical Profile

0 to 2 inches—light yellowish brown, saline and sodic loam
2 to 9 inches—light brown, strong brown and brown, saline and sodic, loam and clay loam
9 to 45 inches—brown and reddish brown, saline and sodic, clay
45 to 60 inches—brown, saline and sodic, sandy clay loam and clay loam

Soil Properties and Qualities

Parent material: basin alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: high
Depth to a limy layer: 20 to 40 inches
Corrosivity: concrete—high; steel—high
Hazard of water erosion: slight
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
- Slickspots that pond water for short periods.

Similar inclusions:
- Soils that have less clay (Casa Grande).
- Soils that have gravelly surfaces.
- Soils that have surface textures of fine sandy loam, sandy loam, clay loam, silt loam, and silty clay loam.
- Soils that do not have accumulations of lime.

Use and Management

Rangeland:

Dominant vegetation:
- Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, Torrey wolfberry
- Present plant community—desert saltbush, thinleaf fourwing saltbush, seepweed, wolfberry, mesquite

Important forage species: evergreen saltbush browse
Major management factors: salinity, sodicity, shrink-swell
General management considerations:
- Potential vegetation is dominated by salt-tolerant shrubs.
- Production on this site is limited by saline-sodic soils.
- This unit is easily traversed by livestock.
- This unit has shade for livestock.
- Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increases the rate of erosion.
- Extra care in management is needed to protect this unit from erosion.
- Salt is generally not needed on this unit because the available browse contains salt.
- When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices:
- Encourage uniform grazing on this unit by developing and controlling permanent waters.
- Provide a protein supplement when annuals are not available.

• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.

Wildlife Habitat

Suitability for desertic herbaceous plants and desertic shrubs and trees: moderately well suited
Suitability for irrigated domestic grasses and legumes: poorly suited

Interpretive Groups

Land capability classification: IIs, irrigated; VIIs, nonirrigated
Range site: Saline Loam, 7- to 10-inch precipitation zone

22—Lagunita silt loam, 0 to 2 percent slopes

Setting

Landform: flood plains
Landscape position: lowlands adjacent to the Gila River
Flooding: rare
Elevation: 1,200 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Lagunita soil and similar soils: 85 percent
Contrasting inclusions: 15 percent

Typical Profile

0 to 11 inches—pale brown and light yellowish brown stratified, saline, silt loam, loamy sand, sand and loamy fine sand
11 to 60 inches—pale brown stratified saline coarse sand

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: excessively drained
Permeability: rapid
Available water capacity: very low

Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: concrete—moderate; steel—high
Hazard of water erosion: slight
Hazard of wind erosion: moderate
Salinity: slight to moderate
Sodicity: slight

Inclusions

Contrasting inclusions:
• Soils that are very gravelly or cobbly (Carrizo).
Similar inclusions:
• Soils that are dominantly fine sand or loamy fine sand (Vint).
• Soils with surface textures of sandy loam or sand.

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, fourwing saltbush
• Present plant community—creosotebush, desert saltbush, paloverde, alkali goldenweed
Important forage species: evergreen saltbush browse
Major management factors: flooding, droughtiness
General management considerations:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• This unit is easily traversed by livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Prevent overgrazing of this unit by fencing or controlling water availability.
• Improve distribution and utilization by concentrating a high number of livestock on the area for a short period of time.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability for desertic riparian herbaceous plants and desertic riparian shrubs and trees: poorly suited

Interpretive Groups

Land capability classification: IVs irrigated, VIIs nonirrigated
Range site: Saline Sandy Loam, 7- to 10-inch precipitation zone

23—Laveen fine sandy loam, saline-sodic, 0 to 2 percent slopes

Setting

Landform: stream terraces
Landscape position: uplands adjacent to the Gila River
Flooding: none
Elevation: 1,000 to 1,250 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Laveen soil and similar soils: 60 percent
Contrasting inclusions: 40 percent

Typical Profile

0 to 3 inches—light yellowish brown, saline and sodic, fine sandy loam
3 to 11 inches—light yellowish brown, saline and sodic, loam
11 to 60 inches—very pale brown, strongly calcareous, saline and sodic, loam

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: moderate
Available water capacity: moderate
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Depth to a limy layer: less than 20 inches
Corrosivity: concrete—moderate; steel—high
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Clayey soils (Kamato).
• Gravelly soils (Rillito).
• Moderately fine textured soils (Casa Grande, Winterburg)
Similar inclusions:
• Soils that have surface textures of sandy loam or loam.
• Moderately coarse textured soils (Coolidge, Denure).

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, Torrey wolfberry
• Present plant community—desert saltbush, thinleaf fourwing saltbush, wolfberry
Important forage species: evergreen saltbush browse
Major management factors: salinity, sodicity
General management considerations:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• This unit is easily traversed by livestock.
• This unit has shade for livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, hazard of wind erosion
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not

protected by vegetation or crop residue helps reduce wind erosion.

Wildlife Habitat

Suitability for desertic herbaceous plants and desertic shrubs and trees: poorly suited
Suitability for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification: IIs irrigated, VIIs nonirrigated
Range site: Saline Loam, 7- to 10-inch precipitation zone

24—Momoli cobbly sandy loam, 5 to 15 percent slopes

Setting

Landform: fan terraces
Landscape position: undulating uplands below the Sierra Estrella
Flooding: none
Elevation: 1,100 to 1,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Momoli soil and similar soils: 85 percent
Contrasting inclusions: 15 percent

Typical Profile

0 to 2 inches—light yellowish brown cobbly sandy loam
2 to 43 inches—reddish yellow very gravelly sandy loam and extremely gravelly loam
43 to 60 inches—reddish yellow very gravelly sandy clay loam

Soil Properties and Qualities

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Corrosivity: concrete—low; steel—high
Hazard of water erosion: moderate
Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
• Soils along drainageways (Carrizo).
• Exposures of hardpan in drainageways.
• Soils with finer textured limy subsoils (Pinamt).
Similar inclusions:
• Soils with less gravel (Denure).
• Soils that have surface textures of cobbly, stony, very gravelly, extremely gravelly, very cobbly and very stony loam, and extremely gravelly sandy loam.
• Areas of slopes ranging from 1 to 20 percent. Some areas adjacent to drainageways range to near vertical.

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—triangle bursage, creosotebush, white ratany, bush muhly
• Present plant community—triangle bursage, paloverde, saquaro, ironwood
Important forage species: bush muhly, big galleta
Major management factors: droughtiness
General management considerations:
• Potential vegetation is dominated by desert trees and shrubs.
• The majority of perennial forage is provided by seasonally available browse.
• The majority of forage is produced on included soils along the drainageways.
• This unit is easily traversed by livestock.
• This unit has shade for livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• A few areas are calcareous in the surface layer and are therefore less productive.
Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability for desertic herbaceous plants: poorly suited
Suitability for desertic shrubs and trees: moderately well suited

Interpretive Groups

Land capability classification: VIIs nonirrigated
Range site: Sandy Loam Upland, 7- to 10-inch precipitation zone

25—Pompeii-Lomitas-Rock outcrop complex, 15 to 65 percent slopes

Setting

Landform: Pompeii—fan terrace; Lomitas—hills and mountains (fig. 10)
Landscape position: Pompeii—base of hills and mountains; Lomitas—hillsides and mountainsides
Flooding: none
Slope range: Pompeii—15 to 50 percent; Lomitas—15 to 65 percent
Elevation: 1,500 to 2,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Pompeii soil and similar soils: 35 percent
Lomitas soil and similar soils: 35 percent
Rock outcrop: 20 percent
Contrasting inclusions: 10 percent

Typical Profile

Pompeii

Rock fragments on the surface: 85 percent gravel, cobble, and stones
0 to 2 inches—yellowish brown extremely cobbly sandy loam
2 to 13 inches—light brown and brown very gravelly sandy loam
13 inches—indurated hardpan

Lomitas

Rock fragments on the surface: 85 percent gravel, cobble, and stones
0 to 2 inches—brown extremely cobbly loam
2 to 17 inches—brown very cobbly loam
17 inches—basalt

Rock outcrop

Consists of areas of exposed basalt

Soil Properties and Qualities

Pompeii

Parent material: colluvium from basalt
Depth class: shallow (to a hardpan)
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: very low
Potential rooting depth: less than 20 inches
Runoff: rapid
Shrink-swell potential: low
Depth to a lime-indurated hardpan: less than 20 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: moderate
Hazard of wind erosion: very slight

Lomitas

Parent material: colluvium from basalt
Depth class: very shallow and shallow
Drainage class: somewhat excessively
Permeability: moderate
Available water capacity: very low
Potential rooting depth: less than 20 inches
Runoff: rapid
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: moderate
Hazard of wind erosion: slight

Inclusions

Contrasting inclusions:
• Deep soils on lower colluvial slopes (Momoli).
• Rubble land on talus slopes.
Similar inclusions:
• Shallow soils that are similar to Pompeii and Lomitas and have a thin hardpan directly overlying basalt bedrock.
• Soils weathered from and underlain by volcanic rocks other than basalt.

Use and Management

Rangeland

Dominant vegetation on the Pompeii soil:
• Potential plant community—white brittlebush, triangle bursage, littleleaf paloverde
• Present plant community—white brittlebush, creosotebush, paloverde, and cactus
Dominant vegetation on the Lomitas soil:
• Potential plant community—littleleaf paloverde, white brittlebush, triangle bursage
• Present plant community—paloverde, brittlebush, creosotebush, and cactus
Important forage species: bush muhly, slim tridens, and big galleta
Major management factors: hardpan, depth to rock, large stones, slope
General management considerations on the Pompeii-Lomitas soils:

• Potential vegetation is dominated by desert trees and shrubs.
• The majority of perennial forage is provided by seasonally available browse.
• Production on this site is limited by shallow soils.
• Proper grazing distribution is difficult on this unit because of steep slopes and unavailability of water.

Suitable management practices on the Pompeii-Lomitas soils:
• Encourage uniform grazing on this unit by fencing and developing permanent water.
• Improve distribution and utilization by concentrating a high number of livestock on the area for a short period of time.
• Use stocker-type cattle on rough slopes that cows with calves will avoid.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Pompeii-Lomitas soils for desertic herbaceous plants: poorly suited
Suitability of the Pompeii-Lomitas soils for desertic shrubs and trees: moderately well suited

Interpretive Groups

Land capability classification:
Pompeii soil—VIIs nonirrigated
Lomitas soil— VIIs nonirrigated
Rock outcrop soil—VIII nonirrigated

Figure 10.—A typical area of Pompeii-Lomitas-Rock outcrop complex, 15 to 65 percent slopes. Talus slopes or "stone stripes" are common on these basalt hills.

Range site:
Pompeii soil—Basalt Hills, 7- to 10-inch precipitation zone
Lomitas soil—Basalt Hills, 7- to 10-inch precipitation zone
Rock outcrop is not assigned to a range site.

26—Quilotosa-Momoli-Vaiva complex, 1 to 15 percent slopes

Setting

Landform: Quilotosa and Vaiva—hills; Momoli—fan terraces
Landscape position: Quilotosa and Vaiva—hillsides; Momoli—base of hills (fig. 11)
Flooding: none
Slope range: Quilotosa—5 to 15 percent; Momoli—1 to 5 percent; Vaiva—1 to 15 percent
Elevation: 1,200 to 1,700 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Quilotosa soil and similar soils: 35 percent
Momoli soil and similar soils: 25 percent
Vaiva soil and similar soils: 15 percent
Contrasting inclusions: 25 percent

Typical Profile

Quilotosa

Rock fragments on the surface: 85 percent fine granitic gravel
0 to 7 inches—light brown very gravelly sandy loam
7 to 13 inches—brown extremely gravelly sandy loam
13 to 15 inches—weathered granite
15 inches—granite

Momoli

Rock fragments on the surface: 90 percent fine granitic gravel
0 to 3 inches—light brown very gravelly sandy loam
3 to 18 inches—reddish yellow very gravelly sandy loam
18 to 47 inches—reddish yellow very gravelly coarse sandy loam
47 to 52 inches—weathered granite

Vaiva

Rock fragments on the surface: 70 percent fine, granitic gravel
0 to 1 inch—reddish yellow extremely gravelly sandy loam
1 to 9 inches—red very gravelly sandy clay loam
9 to 18 inches—weathered granite
18 inches—granite

Soil Properties and Qualities

Quilotosa

Parent material: alluvium and colluvium
Depth class: very shallow and shallow
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: very low
Potential rooting depth: less than 20 inches
Runoff: rapid
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: moderate
Hazard of wind erosion: very slight

Momoli

Parent material: fan alluvium
Depth class: deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: very low
Potential rooting depth: 40 or more inches
Runoff: moderate
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Vaiva

Parent material: alluvium and colluvium
Depth class: shallow
Drainage class: well
Permeability: moderately slow
Available water capacity: very low
Potential rooting depth: less than 20 inches
Runoff: moderate
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
• Areas of rock outcrop.
• Soils subject to flooding (Carrizo, Why).
Similar inclusions:
• Soils moderately deep to bedrock.
• Soils that are similar to Momoli and have less than 35 percent gravel (Denure).

Use and Management

Rangeland

Dominant vegetation on the Quilotosa soil:
• Potential plant community—creosotebush, littleleaf paloverde, ironwood, white ratany
• Present plant community—paloverde, creosotebush, triangle bursage, jumping cholla, range ratany
Dominant vegetation on the Momoli soil:
• Potential plant community—creosotebush, triangle bursage, bush muhly, white ratany
• Present plant community—creosotebush, triangle bursage, range ratany
Dominant vegetation on the Vaiva soil:
• Potential plant community—triangle bursage, littleleaf paloverde, flattop wildbuckwheat, white ratany
• Present plant community—creosotebush, triangle bursage, range ratany, yerba del venado
Important forage species: bush muhly, big galleta, and winter-spring annuals
Major management factors: droughtiness, slope, depth to rock
General management considerations on the Quilotosa and Momoli soils:
• These soils are among the least productive in the survey area.
• Potential vegetation is dominated by desert shrubs.
• The majority of forage is produced on included soils along the drainageways.
• Production is limited by the high lime content (Momoli) and shallow depth to bedrock (Quilotosa).
• These soils are easily traversed by livestock.
• Proper grazing distribution is difficult on these soils because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
Suitable management practices on the Quilotosa and Momoli soils:
• Encourage uniform grazing on these soils by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.

Figure 11.—A typical area of Quilotosa-Momoli-Vaiva complex, 1 to 15 percent slopes.

• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

General management considerations on the Vaiva soil:
• Potential vegetation is dominated by desert shrubs.
• The majority of perennial forage is provided by seasonally available browse.
• The majority of forage is produced on included soils along the drainageways.
• Production on this soil is limited by shallow depth to bedrock.
• Livestock movement is hindered by steep cobbly slopes.
• Proper grazing distribution is difficult on this unit because of steep slopes and the unavailability of water.
• Overgrazing reduces the plant cover and increases the rate of erosion.

Suitable management practices on the Vaiva soil:
• Encourage uniform grazing on this soil by fencing and developing permanent water.
• Improve distribution and utilization by concentrating a high number of livestock on the area for a short period of time.
• Use stocker-type cattle on rough slopes that cows with calves will avoid.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Quilotosa and Vaiva soils for desertic herbaceous plants: poorly suited
Suitability of the Quilotosa and Vaiva soils for desertic shrubs and trees: moderately well suited
Suitability of the Momoli soil for desertic herbaceous plants: moderately well suited
Suitability of the Momoli soil for desertic shrubs and trees: poorly suited

Interpretive Groups

Land capability classification:
Quilotosa soil—VIIs nonirrigated
Momoli soil—VIIs nonirrigated
Vaiva soil—VIIs nonirrigated
Range site:
Quilotosa soil—Limy Upland, 7- to 10-inch precipitation zone
Momoli soil—Limy Upland, (deep), 7- to 10-inch precipitation zone
Vaiva soil—Shallow Upland, 7- to 10-inch precipitation zone

27—Quilotosa-Rock outcrop-Vaiva complex, 20 to 65 percent slopes

Setting

Landform: hills and mountains
Landscape position: hillsides and mountainsides (fig. 12)
Flooding: none
Slope range: Quilotosa—20 to 65 percent, Vaiva—20 to 25 percent
Elevation: 1,150 to 3,100 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Quilotosa soil and similar soils: 50 percent
Rock outcrop soil and similar soils: 30 percent
Vaiva soil and similar soils: 10 percent
Contrasting inclusions: 10 percent

Typical Profile

Quilotosa

0 to 1 inch—yellowish brown extremely gravelly sandy loam
1 to 9 inches—brown extremely gravelly sandy loam
9 to 16 inches—pink partially weathered granite
16 inches—granite

Vaiva

0 to 1 inch—yellowish brown extremely gravelly sandy loam
1 to 8 inches—reddish brown extremely gravelly sandy clay loam
8 to 18 inches—reddish brown and reddish yellow weathered granite
18 inches—granite

Rock outcrop

Consists of exposed areas of granite and gneiss

Soil Properties and Qualities

Quilotosa

Parent material: alluvium and colluvium
Depth class: very shallow and shallow
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: very low
Potential rooting depth: less than 20 inches
Runoff: rapid
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low

Hazard of water erosion: severe
Hazard of wind erosion: very slight

Vaiva

Parent material: alluvium and colluvium
Depth class: very shallow and shallow
Drainage class: well
Permeability: moderately slow
Available water capacity: very low
Potential rooting depth: less than 20 inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low

Hazard of water erosion: moderate
Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
- Soils underlain by schist.
- Areas of near vertical slopes.
- Deep soils on fan terraces at the base of Pima Butte (Momoli, Pinamt).
- Coarse textured soils in washes (Carrizo).

Similar inclusions:
- Soils that have surface textures of cobbly or stony

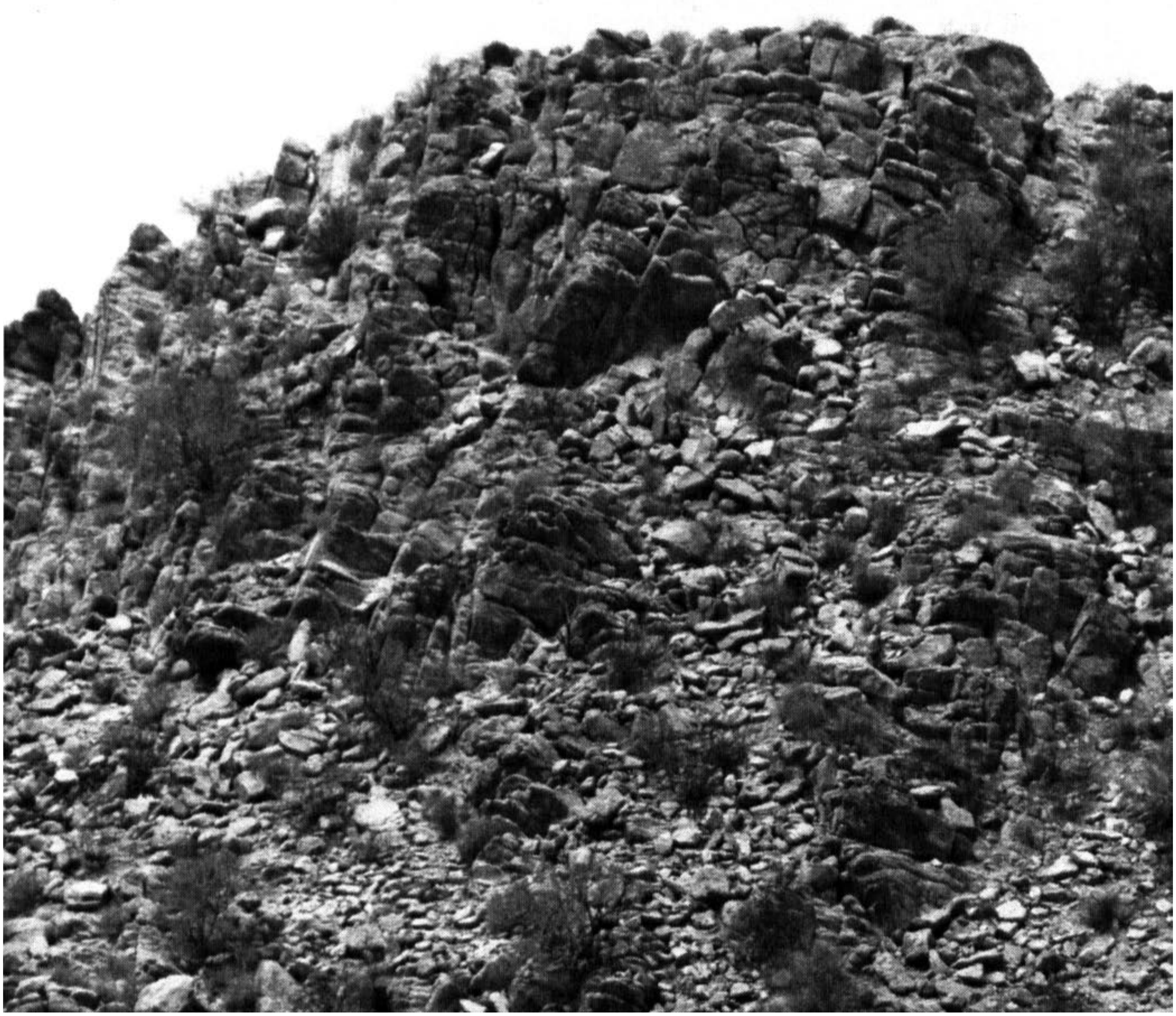


Figure 12.—A typical area of Quilotosa-Rock outcrop-Vaiva complex, 20 to 65 percent slopes.

sandy loam, very gravelly sandy loam, or extremely gravelly loam.
• Soils that are moderately deep to bedrock.

Use and Management

Rangeland

Dominant vegetation on the Quilostosa soil:
• Potential plant community—littleleaf paloverde, triangle bursage, white brittlebush
• Present plant community—brittlebush, triangle bursage, paloverde, creosotebush, cactus
Dominant vegetation on the Vaiva soil:
• Potential plant community—littleleaf paloverde, white brittlebush, triangle bursage
• Present plant community—brittlebush, triangle bursage, paloverde, creosotebush, cactus
Important forage species: bush muhly, slim tridens, and big galleta
Major management factors: slope, depth to rock, droughtiness
General management considerations on the Quilotosa-Vaiva soils:
• Potential vegetation is dominated by desert shrubs.
• The majority of perennial forage is provided by seasonally available browse.
• The majority of forage is produced on included soils along the drainageways.
• Production on this site is limited by shallow soils.
• Livestock movement is hindered by steep cobbly slopes.
• Proper grazing distribution is difficult on this unit because of steep slopes and the unavailability of water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
Suitable management practices on the Quilostosa-Vaiva soils:
• Encourage uniform grazing on this unit by fencing and developing permanent water.
• Improve distribution and utilization by concentrating a high number of livestock on the area for a short period of time.
• Use stocker-type cattle on rough slopes that cows with calves will avoid.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Quilotosa-Vaiva soils for desertic herbaceous plants: poorly suited
Suitability for the Quilotosa-Vaiva soils for desertic shrubs and trees: moderately well suited

Interpretive Groups

Land capability classification:
Quilotosa soil—VIIe nonirrigated
Vaiva soil—VIIe nonirrigated
Rock outcrop soil—VIII nonirrigated
Range site:
Quilotosa soil—Granitic Hills, 7- to 10-inch precipitation zone
Vaiva soil—Granitic Hills, 7- to 10-inch precipitation zone
Rock outcrop is not assigned to a range site.

28—Redun-Shontik complex, 1 to 3 percent slopes

Setting

Landform: fan terraces
Landscape position: broad undulating uplands bordering mountains
Flooding: none
Slope range: 1 to 3 percent
Elevation: 1,000 to 1,250 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Redun soil and similar soils: 50 percent
Shontik soil and similar soils: 40 percent
Contrasting inclusions: 10 percent

Typical Profile

Redun

0 to 4 inches—light brown, saline, fine sandy loam
4 to 49 inches—light brown, saline and sodic, sandy loam
49 to 60 inches—reddish yellow, saline and sodic, fine sandy loam

Shontik

0 to 3 inches—light yellowish brown fine sandy loam
3 to 21 inches—light brown, saline and sodic sandy loam

21 to 60 inches—reddish yellow and strong brown, saline and sodic, sandy clay loam and loam

Soil Properties and Qualities

Redun

Parent material: fan alluvium
Depth class: very deep
Drainage class: well drained
Permeability: slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Depth to a limy layer: few lime masses lower part
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: strong
Sodicity: strong

Shontik

Parent material: fan alluvium
Depth class: very deep
Drainage class: well
Permeability: moderate and moderately rapid—upper part (above 21 inches), slow—lower part (below 21 inches)
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: moderate
Depth to a limy layer: lime masses lower part
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Soils in drainageways (Why).
• Soils that have very limy layers.
• Soils that have sandy clay loam or clay loam subsoils (Casa Grande).
• Slickspots
Similar inclusions:
• Soils that are similar to Denure and average very fine sandy loam or loam in the control section (Dateland).
• Soils that are irrigated in the San Carlos irrigation district and have dark brown loam or clay loam surface layers ranging in thickness from 5 to 15 inches.
• Soils that have minor strata of gravelly loamy sand.
• Soils that have more than 15 percent rock fragments throughout.
• Soils that are not saline and sodic on the proximal end of the map unit.
• Soils that are on alluvial fans at the distal end of the map unit and are subject to occasional brief periods of flooding.

Use and Management

Rangeland

Dominant vegetation on the Redun soil:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry
• Present plant community—desert saltbush, creosotebush, annuals
Dominant vegetation on the Shontik soil:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry
• Present plant community—desert saltbush, creosotebush, annuals
Important forage species: evergreen saltbush browse
Major management factors: salinity, sodicity, droughtiness
General management considerations on the Redun-Shontik soils:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• This unit is easily traversed by livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices on the Redun-Shontik soils:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Prevent overgrazing of this unit by fencing or controlling water availability.
• Improve distribution and utilization by concentrating a high number of livestock on the area for a short period of time.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, hazard of wind erosion
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The included soils on alluvial fans are subject to sheet flooding during prolonged high intensity storms. Where unprotected cropland adjoins these areas the cropland is subject to flooding and erosion.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed throught the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• Dikes and diversions can be used to help reduce the risk of flooding of the included soils.

Building Site Development

Major management factors: cutbanks cave, shrink-swell, salinity, sodicity, slow permeability, corrosion hazard
General management considerations:
• Cutbanks are not stable and therefore are subject to slumping.
• Damage to structures from shrinking and swelling of the buried subsoil is possible.
• Excavation increases the risk of water erosion.
• Preserve as many salt- and sodium-tolerant plants as possible during construction.
• Onsite investigation is needed to determine whether the area considered for a septic tank absorption field is underlain by unsuitable material. If such a material is present, consider placing absorption lines beneath or adjacent to it.
• Septic tank absorption fields can be expected to function poorly because of the limited permeability of the buried subsoil, which restricts the movement and filtration of effluent.
• Included soils on alluvial fans are subject to sheet flooding during prolonged high intensity storms. Unprotected building sites are subject to flooding in these areas.
Suitable management practices:
• Provide excavations with sloped banks or shoring to prevent cutbanks from caving in.
• Prevent structural damage that results from shrinking and swelling by designing foundations and footings to allow for shrinking and swelling and by diverting runoff away from buildings.
• Reduce the risk of erosion and the maintenance cost by stabilizing areas that have been disturbed.
• Select salt- and sodium-tolerant plants for landscaping.
• Install absorption lines below the layer that has restricted permeability or compensate with additional absorption lines and sandy backfill.
• Offset the risk of corrosion to uncoated steel and concrete by using treated steel pipe and sulphate-resistant cement.

• Compact the building site before beginning construction to minimize the possibility of settlement.
• Install culverts to carry seasonal runoff where roads cross natural drainageways.
• The risk of flooding of included soils can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability of the Redun-Shontik soils for desertic herbaceous plants and desertic shrubs and trees: poorly suited
Suitability of the Redun-Shontik soils for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification:
Redun soil—IIs irrigated, VIIs nonirrigated
Shontik soil—IIs irrigated, VIIs nonirrigated
Range site:
Redun soil— Saline Sandy Loam, 7- to 10-inch precipitation zone
Shontik soil—Saline Sandy Loam, 7- to 10-inch precipitation zone

29—Rillito-Gunsight complex, 3 to 15 percent slopes

Setting

Landform: fan terraces
Landscape position: slightly elevated uplands adjacent to drainageways
Flooding: none
Slope range: 3 to 15 percent
Elevation: 1,100 to 1,500 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Rillito soil and similar soils: 35 percent
Gunsight soil and similar soils: 20 percent
Contrasting inclusions: 45 percent

Typical Profile

Rillito

0 to 1 inch—yellow, strongly calcareous, gravelly sandy loam
1 to 10 inches—white, strongly calcareous, gravelly sandy loam
10 to 45 inches—white and light yellowish brown, strongly calcareous, very gravelly sandy loam and gravelly loam
45 to 60 inches—very pale brown, strongly calcareous, loam

Gunsight

0 to 1 inch—very pale brown very gravelly loam
1 to 16 inches—pink and reddish yellow strongly calcareous, fine sandy loam and very gravelly fine sandy loam
16 to 42 inches—very pale brown, pale brown, and light brownish gray, strongly calcareous, very gravelly loam and very gravelly sandy loam
42 to 60 inches—very pale brown, strongly calcareous, loam

Soil Properties and Qualities

Rillito

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderate
Available water capacity: moderate
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Depth to a limy layer: less than 20 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: moderate
Hazard of wind erosion: moderately high

Gunsight

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderate
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: moderate
Shrink-swell potential: low
Depth to a limy layer: less than 20 inches
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very slight

Inclusions

Contrasting inclusions:
• Soils on sand dunes (Rositas).
• Soils having hardpans (Cavelt).
• Soils along washes (Brios, Why).
Similar inclusions:
• Areas that have slopes ranging to 20 percent.
• Soils that have surface textures of gravelly and very

gravelly sandy loam, gravelly fine sandy loam, and fine sandy loam.
- Soils that have more clay in the subsoil (Pinamt).

Use and Management

Rangeland

Dominant vegetation on the Rillito soil:
- Potential plant community—creosotebush, triangle bursage, white bursage, white ratany
- Present plant community—creosotebush, white bursage, paloverde, ironwood

Dominant vegetation on the Gunsight soil:
- Potential plant community—creosotebush, triangle bursage, white bursage
- Present plant community—creosotebush, white bursage, paloverde, ironwood

Important forage species: winter-spring annuals
Major management factors: droughtiness, very limy layer
General management considerations on the Rillito-Gunsight soils:
- This unit is among the least productive in the survey area.
- Potential vegetation is dominated by desert shrubs.
- The majority of forage is produced on included soils along the drainageways.
- Production on this site is limited by the high lime content in the soils.
- This unit is easily traversed by livestock.
- Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increases the rate of erosion.

Suitable management practices on the Rillito-Gunsight soils:
- Encourage uniform grazing on this unit by developing and controlling permanent waters.
- Concentrate management on included soils in the drainageways where the majority of forage is produced.
- Control erosion and promote forage production with proper utilization.
- Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Rillito-Gunsight soils for desertic herbaceous plants and desertic shrubs and trees: poorly suited

Interpretive Groups

Land capability classification:
Rillito soil—VIIs nonirrigated
Gunsight soil—VIIs nonirrigated

Range site:
Rillito soil—Limy Upland (deep), 7- to 10-inch precipitation zone
Gunsight soil—Limy Upland (deep), 7- to 10-inch precipitation zone

30—Rositas-Casa Grande-Slickspots complex, 1 to 15 percent slopes

Setting

Landform: Rositas—sand dunes, Casa Grande—relict basin floor; Slickspots—playas
Landscape position: Casa Grande—undulating broad uplands between sand dunes; Slickspots—nearly level playa-like depressions between sand dunes
Flooding: Rositas-Casa Grande-none; Slickspots-ponding
Slope range: Rositas—1 to 15 percent; Casa Grande—1 to 5 percent; Slickspots—0 to 2 percent
Elevation: 1,000 to 1,200 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Rositas soil and similar soils: 30 percent
Casa Grande soil and similar soils: 30 percent
Slickspots and similar soils: 30 percent
Contrasting inclusions: 10 percent

Typical Profile

Rositas

0 to 8 inches—very pale brown, sodic sand
8 to 60 inches—yellow and brownish yellow, crossbedded, stratified sodic, sand, fine sand, and loamy fine sand

Casa Grande

0 to 3 inches—very pale brown, saline and sodic, silt loam
3 to 20 inches—reddish brown, brown and yellowish brown, saline and sodic, loam
20 to 60 inches—brown and light gray, saline and sodic, sandy clay loam, and loam

Slickspots

Crusted, very smooth, impervious, saline and sodic surfaces, that range from fine sand to clay overlying strongly consolidated siltstone and/or hardpans of variable composition

Soil Properties and Qualities

Rositas

Parent material: eolian
Depth class: very deep
Drainage class: somewhat excessively
Permeability: rapid
Available water capacity: very low to low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very high
Sodicity: slight

Casa Grande

Parent material: basin alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: moderate
Depth to a limy layer: 20 to 40 inches
Corrosivity: steel—high; concrete—high
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Slickspots

Parent material: basin alluvium
Depth class: very shallow to very deep
Drainage class: well
Permeability: very slow
Available water capacity: very low
Potential rooting depth: 7 to 60 or more inches
Runoff: slow
Shrink-swell potential: low to high
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: slight
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Soils with sand over silt loam and silty clay loam at moderate depths.
• Soils with large volume of nodules.
• Areas that have a gravelly and very gravelly surface.
• Soils that are very fine sandy loam throughout (Dateland).
• Soils that have very strongly saline strata (Yahana).
Similar inclusions:
• Soils that have surface textures of fine sand, loamy fine sand, fine sandy loam, and sandy loam.
• Areas of slopes ranging from 0 to 25 percent.

Use and Management

Rangeland

Dominant vegetation on the Rositas soil:
• Potential plant community—big galleta, desert saltbush, fourwing saltbush, white bursage
• Present plant community—big galleta, desert saltbush, annuals
Dominant vegetation on the Casa Grande soil:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, Torrey wolfberry
• Present plant community—seepweed, desert saltbush, mesquite, wolfberry
Dominant vegetation on the Slickspots:
• Potential plant community—barren
• Present plant community—barren
Important forage species: big galleta
Major management factors: salinity, sodicity, hazard of wind erosion
General management considerations on the Rositas soil:
• Potential vegetation is dominated by a mixture of salt-tolerant grasses and shrubs.
• Livestock movement is hindered by loose sands.
• Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from erosion.
• Avoid grazing this soil during the spring because of the availability of black greasewood, a plant toxic to livestock.
• Salt is generally not needed on this soil because the available browse contains salt.
Suitable management practices on the Rositas soil:
• Provide erosion protection if the plant cover is disturbed.
• Encourage uniform grazing on this soil by developing and controlling permanent waters.
• Control erosion and promote forage production with proper utilization.

• Provide periodic rest during the growing season to maintain plant vigor and production.

General management considerations on the Casa Grande soil:

• Potential vegetation is dominated by salt-tolerant shrubs.

• The majority of perennial forage is provided by evergreen saltbush browse.

• Production on this soil is limited by saline-sodic soils.

• This soil is easily traversed by livestock.

• This soil has shade for livestock.

• Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.

• Overgrazing reduces the plant cover and increases the rate of erosion.

• Extra care in management is needed to protect this soil from erosion.

• Salt is generally not needed on this soil because the available browse contains salt.

• When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices on the Casa Grande soil:

• Encourage uniform grazing on this soil by developing and controlling permanent waters.

• Provide a protein supplement when annuals are not available.

• Control erosion and promote forage production with proper utilization.

• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Rositas soil for desertic herbaceous plants and desertic trees and shrubs: moderately well suited

Suitability of the Casa Grande soil for desertic herbaceous plants and desertic trees and shrubs: poorly suited

Interpretive Groups

Land capability classification:

Rositas soil—VIIs nonirrigated

Casa Grande soil—VIIs nonirrigated

Range site:

Rositas soil—Sandy Upland (saline), 7- to 10-inch precipitation zone

Casa Grande soil—Saline Loam, 7- to 10-inch precipitation zone

Slickspots—no range site assigned

31—Rositas loamy fine sand, sodic, 0 to 3 percent slopes

Setting

Landform: sand dunes

Flooding: none

Elevation: 1,000 to 1,200 feet

Mean annual precipitation: 7 to 10 inches

Mean annual air temperature: 69 to 73 degrees F

Frost-free period: 240 to 280 days

Composition

Rositas soil and similar soils: 90 percent

Contrasting inclusions: 10 percent

Typical Profile

0 to 1 inch—pale brown, sodic, loamy fine sand

1 to 60 inches—light yellowish brown, cross bedded, stratified, sodic, loamy fine sand

Soil Properties and Qualities

Parent material: eolian

Depth class: very deep

Drainage class: somewhat excessively

Permeability: rapid

Available water capacity: very low to low

Potential rooting depth: 60 or more inches

Runoff: slow

Shrink-swell potential: low

Corrosivity: concrete—low; steel—high

Hazard of water erosion: slight

Hazard of wind erosion: high

Sodicity: slight

Inclusions

Contrasting inclusions:

• Finer textured saline and sodic soils (Casa Grande, Shontik).

• Soils that have buried sandy clay loam subsoils at a moderate depth.

Similar inclusions:

• Soils that have surface textures of loamy sand and fine sandy loam.

• Areas of slopes that range to 4 percent. Some eroded areas adjacent to the Gila River range to 8 percent

Use and Management

Rangeland:

Dominant vegetation:

• Potential plant community—big galleta, desert saltbush, white bursage, fourwing saltbush

• Present plant community—desert saltbush, big galletta, white bursage, greasewood

Important forage species: big galleta

Major management factors: droughtiness, hazard of wind erosion

General management considerations:

• Potential vegetation is dominated by a mixture of salt-tolerant grasses and shrubs.
• Important perennial forage potentially includes big galleta.
• Livestock movement is hindered by loose sands.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Avoid grazing this unit during the spring because of the availability of black greasewood, a plant toxic to livestock.
• Salt is generally not needed on this unit because the available browse contains salt.

Suitable management practices:

• Provide erosion protection if the plant cover is disturbed.
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, sodicity, fast intake

General management considerations:

• Most climatically suited crops can be grown on this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• Leveling cuts will expose sand.
• Water can be distributed by concrete-lined ditches or pipelines.

Suitable management practices:

• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Farming on the contour or across the slope, where practical, reduces runoff and helps control water erosion.
• Irrigation water can be applied efficiently by using sprinkler, drip, border, or furrow irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field to a basin system may be prohibitive. A graded system is more feasible in those areas.
• To avoid overirrigating and leaching of plant nutrients and to reduce the risk of water erosion, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs.
• Line irrigation ditches with concrete or install pipelines to reduce loss of water by seepage.
• The condition of the soil is maintained or improved by returning crop residue to the soil and by keeping tillage to a minimum.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• The risk of flooding from included soils in small drainageways can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability for desertic herbaceous plants and desertic shrubs and trees: moderately well suited

Interpretive Groups

Land capability classification: IIIs irrigated, VIIs nonirrigated

Range site: Sandy Upland (saline), 7- to 10-inch precipitation zone

32—Shontik-Redun complex, 0 to 3 percent slopes

Setting

Landform: stream terraces
Landscape position: broad undulating uplands bordering the Gila River
Flooding: none
Slope range: 0 to 3 percent
Elevation: 1,000 to 1,250 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Shontik soil and similar soils: 50 percent
Redun soil and similar soils: 35 percent
Contrasting inclusions: 15 percent

Typical Profile

Shontik

0 to 9 inches—light yellowish brown, saline and sodic, fine sandy loam

9 to 28 inches—reddish yellow, saline and sodic, fine sandy loam
28 to 60 inches—light reddish brown and light brown saline and sodic clay loam, and sandy clay loam

Redun

0 to 6 inches—light yellowish brown, saline and sodic, fine sandy loam
6 to 42 inches—strong brown, saline and sodic, sandy loam
42 to 60 inches—reddish yellow, saline and sodic, fine sandy loam

Soil Properties and Qualities

Shontik

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: moderate and moderately rapid—upper part (above 28 inches); slow—lower part (below 28 inches)
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: moderate
Depth to a limy layer: 20 to 40 inches
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderately high
Salinity: strong
Sodicity: strong

Redun

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—high
Hazard of water erosion: slight
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Soils that have sandy clay loam or clay loam subsoils (Casa Grande).
• Soils that have clayey subsoils (Kamato).
• Soils that have very limy layers (Laveen, Rillito).

Similar inclusions:
• Soils that have surface textures of loamy fine sand, loamy very fine sand, very fine sandy loam, and sandy loam.
• Soils that are irrigated in the San Carlos irrigation district and have dark brown loam or clay loam surface layers ranging in thickness from 5 to 15 inches.
• Areas having slopes to 5 percent; ranging to near vertical adjacent to the Gila River.
• Soils that are very fine sandy loam throughout (Dateland).

Use and Management

Rangeland

Dominant vegetation on the Shontik soil:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry
• Present plant community—desert saltbush, thinleaf fourwing saltbush, wolfberry, annuals
Dominant vegetation on the Redun soil:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry
• Present plant community—desert saltbush, thinleaf fourwing saltbush, wolfberry, annuals
Important forage species: evergreen saltbush browse
Major management factors: salinity, sodicity, droughtiness
General management considerations on the Shontik-Redun soils:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• This unit is easily traversed by livestock.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices on the Shontik-Redun soils:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.
• Prevent overgrazing of this unit by fencing or controlling water availability.
• Improve distribution and utilization by concentrating a high number of livestock on the area for a short period of time.

• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, hazard of wind erosion
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kinds and amounts of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system having a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.

Building Site Development

Major management factors: cutbanks cave, shrink-swell, salinity, sodicity, slow permeability, corrosion hazard
General management considerations:
• Cutbanks are not stable and therefore are subject to slumping.
• Damage to structures from shrinking and swelling of the buried subsoil is possible.
• Excavation increases the risk of water erosion.
• Preserve as many salt- and sodium-tolerant plants as possible during construction.
• Onsite investigation is needed to determine whether the area considered for a septic tank absorption field is underlain by unsuitable material. If such material is present, consider placing absorption lines beneath or adjacent to it.
• Septic tank absorption fields can be expected to function poorly because of the limited permeability of the buried subsoil, which restricts the movement and filtration of effluent.
Suitable management practices:
• Provide excavations with sloped banks or shoring to prevent cutbanks from caving in.
• Prevent structural damage that results from shrinking and swelling by designing foundations and footings to allow for shrinking and swelling and by diverting runoff away from buildings.
• Reduce the risk of erosion and the maintenance cost by stabilizing areas that have been disturbed.
• Select salt- and sodium-tolerant plants for landscaping.
• Install absorption lines below the layer that has restricted permeability or compensate with additional absorption lines and sandy backfill.
• Offset the risk of corrosion to uncoated steel and concrete by using treated steel pipe and sulphate-resistant cement.
• Compact the building site before beginning construction to minimize the possibility of settlement.

• Install culverts to carry seasonal runoff where roads cross natural drainageways.

Wildlife Habitat

Suitability of the Shontik-Redun soils for desertic herbaceous plants and desertic shrubs and trees: poorly suited
Suitability of the Shontik-Redun soils for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification:
Shontik soil—IIs irrigated, VIIs nonirrigated
Redun soil—IIs irrigated, VIIs nonirrigated
Range site:
Shontik soil—Saline Sandy Loam, 7- to 10-inch precipitation zone
Redun soil—Saline Sandy Loam, 7- to 10-inch precipitation zone

33—Tatai silt loam, 0 to 2 percent slopes

Setting

Landform: stream terraces
Landscape position: broad undulating uplands bordering the Gila River
Flooding: none
Elevation: 1,000 to 1,200 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Tatai soil and similar soils: 75 percent
Contrasting inclusions: 25 percent

Typical Profile

0 to 6 inches—light yellowish brown and yellowish brown, silt loam
6 to 24 inches—light brown and light yellowish brown, saline and sodic, silt loam
24 to 60 inches—brown, yellowish red and reddish brown saline and sodic loam and clay loam

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: moderate—upper part (above 24 inches), slow—lower part (below 24 inches)
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: moderate
Depth to a limy layer: 20 to 40 inches
Corrosivity: concrete—moderate; steel—high
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Salinity: moderate
Sodicity: moderate

Inclusions

Contrasting inclusions:
• Clayey soils (Kamato).
• Moderately coarse textured soils (Redun).
• Soils that are moderately coarse over a moderately fine textured buried subsoil (Shontik).
Similar inclusions:
• Soils that have less than 18 percent clay in the control section.
• Soils that lack buried subsoils.
• Soils that have gravelly surfaces.
• Soils that have surface textures of loam, silt loam and silty clay loam.

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, Torrey wolfberry
• Present plant community—mesquite, desert saltbush, thinleaf fourwing saltbush, wolfberry, annuals
Important forage species: evergreen saltbush browse
Major management factors: salinity, sodicity
General management considerations:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this site is limited by saline-sodic soils.
• This unit is easily traversed by livestock.
• This unit has shade for livestock.
• Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices:
• Encourage uniform grazing on this unit by developing and controlling permanent waters.

• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by concrete-lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and mangagement of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.

Wildlife Habitat

Suitability for desertic, herbaceous plants and desertic shrubs and trees: moderately well suited
Suitability for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification: IIs irrigated, VIIs nonirrigated
Range site: Saline Loam, 7- to 10-inch precipitation zone

34—Trix loam, saline-sodic, 0 to 1 percent slopes

Setting

Landform: flood plains
Landscape position: lowlands along tributaries of the Gila River
Flooding: occasional
Elevation: 1,000 to 1,200 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Trix soil and similar soils: 90 percent
Contrasting inclusions: 10 percent

Typical Profile

0 to 5 inches—brown, saline and sodic, loam
5 to 60 inches—brown and light brown, stratified saline and sodic, loam and clay loam

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: moderately slow

Available water capacity: low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: concrete—high; steel—high
Hazard of water erosion: slight
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Soils that have a buried subsoil at depths of 40 inches or more.
• Soils that have limy subsoils (Casa Grande).
• Soils that are coarser textured (Redun).
• Soils that are siltier (Indio).
• Slickspots
• Severely eroded, nearly barren areas along McClellan Wash.
Similar inclusions:
• Soils that have surface textures of very fine sandy loam, fine sandy loam or silty clay loam.
• Soils that have slopes of as much as 3 percent.

Use and Management

Rangeland

Dominant vegetation:
• Potential plant community—alkali sacaton, thinleaf fourwing saltbush, seepweed, mesquite, inland saltgrass
• Present plant community—mesquite, wolfberry, seepweed, desert saltbush
Important forage species: alkali sacaton, twoflower trichloris, and inland saltgrass
Major management factors: flooding, salinity, sodicity
General management considerations:
• This unit is among the most productive in the survey area.
• Potential vegetation is dominated by a mixture of salt-tolerant grasses and shrubs.
• This unit benefits from run-on moisture, which increases the amount of forage produced.
• Livestock movement is hindered by dense brushy growth.
• This unit has shade for livestock.
• Livestock will generally overgraze this area, unless controlled, because of the availability of water and abundance of feed.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.
• Salt is generally not needed on this unit because the available browse contains salt.
Suitable management practices:
• Thin trees to encourage production of perennial grasses.
• Provide erosion protection if the plant cover is disturbed.
• Seeding can be used to improve range condition when there are not enough remnant perennial grasses to reestablish the site.
• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Prevent overgrazing of this unit by fencing or controlling water availability.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity, flooding
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
• The available water capacity is for natural conditions. The available water capacity for irrigated conditions will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.
Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by soil tests.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional

increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• The risk of flooding can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability for desertic riparian herbaceous plants and desertic shrubs and trees: moderately well suited
Suitability for irrigated grain and seed crops and irrigated domestic grasses and legumes: poorly suited

Interpretive Groups

Land capability classification: IIIw irrigated, VIIw nonirrigated
Range site: Saline Bottom, 7- to 10-inch precipitation zone

35—Vint-Yahana complex, saline-sodic, 0 to 10 percent slopes

Setting

Landform: flood plains
Landscape position: Vint—sand splays on lowlands adjacent to the Gila River; Yahana—lowlands adjacent to the Gila River
Flooding: rare
Slope range: 0 to 10 percent
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Vint soil and similar soils: 30 percent
Yahana soil and similar soils: 30 percent
Contrasting inclusions: 40 percent

Typical Profile

Vint

0 to 43 inches—very pale brown, stratified sodic, loamy fine sand
43 to 60 inches—light yellowish brown, stratified saline and sodic, fine sandy loam and loam

Yahana

0 to 13 inches—light yellowish brown and brown saline and sodic, fine sandy loam
13 to 60 inches—pale brown and light yellowish brown, stratified saline and sodic, silt loam and silty clay

Soil Properties and Qualities

Vint

Parent material: stream alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Hazard of water erosion: slight
Hazard of wind erosion: high
Salinity: moderate
Sodicity: strong
Shrink-swell potential: low
Corrosivity: steel—high; concrete—moderate

Yahana

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: high
Corrosivity: steel—high; concrete—high
Hazard of water erosion: moderate
Hazard of wind erosion: moderately high
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Soils on sand dunes (Rositas).

- Slickspots that pond water.
- Soils that are underlain by sand at moderate depths.
- Sandy that are over clayey soils at moderate depths.

Similar inclusions:
- Soils that have surface textures of fine sand, very fine sand, loamy very fine sand, very fine sandy loam, silt loam, or silty clay loam.
- Areas with slopes ranging to 25 percent; to near vertical adjacent to the Gila River.
- Soils that are very fine sandy loam throughout.
- Soils that are silt loam throughout (Indio).

Use and Management

Rangeland

Dominant vegetation on the Vint soil:
- Potential plant community—desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry
- Present plant community—desert saltbush, mesquite, Anderson wolfberry, greasewood, Torrey seepweed, annuals.

Dominant vegetation on the Yahana soil:
- Potential plant community—Torrey seepweed, thinleaf fourwing saltbush, black greasewood
- Present plant community—desert saltbush, mesquite, black greasewood, Torrey seepweed

Important forage species: evergreen saltbush browse
Major management factors: flooding, salinity, sodicity
General management considerations on the Vint soil:
- Potential vegetation is dominated by salt-tolerant shrubs.
- Production on this soil is limited by saline-sodic condition.
- This soil is easily traversed by livestock.
- Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increases the rate of erosion.
- Salt is generally not needed on this soil because the available browse contains salt.
- When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices on the Vint soil:
- Encourage uniform grazing on this soil by developing and controlling permanent waters.
- Prevent overgrazing of this soil by fencing or controlling water availability.
- Improve distribution and utilization by concentrating a high number of livestock on the area for a short period of time.
- Provide a protein supplement when annuals are not available.
- Control erosion and promote forage production with proper utilization.
- Provide periodic rest during the growing season to maintain plant vigor and production.

General management considerations on the Yahana soil:
- This soil is among the least productive in the survey area.
- Potential vegetation is dominated by salt-tolerant shrubs.
- Production on this soil is limited by saline-sodic condition.
- This soil is easily traversed by livestock.
- Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increases the rate of erosion.
- Extra care in management is needed to protect this soil from erosion.
- Avoid grazing this soil during the spring because of the availability of black greasewood, a plant toxic to livestock.
- Salt is generally not needed on this soil because the available browse contains salt.
- When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices on the Yahana soil:
- Use water-spreading dikes to increase the area that benefits from run-on moisture.
- Encourage uniform grazing on this unit by developing and controlling permanent waters.
- Concentrate management on included soils in the drainageways where the majority of forage is produced.
- Provide a protein supplement when annuals are not available.
- Control erosion and promote forage production with proper utilization.
- Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Vint-Yahana soils for desertic herbaceous plants and desertic shrubs and trees: very poorly suited

Interpretive Groups

Land capability classification:
Vint soil—IIIs irrigated, VIIs nonirrigated
Yahana soil—IIs irrigated, VIIs nonirrigated
Range site:
Vint soil—Saline Sandy Loam, 7- to 10-inch precipitation zone
Yahana soil—Alkali Flat, 7- to 10-inch precipitation zone

36—Why-Brios complex, 0 to 2 percent slopes

Setting

Landform: alluvial fans
Landscape position: areas where drainageways emerge from hills and mountains onto lower-lying plains
Flooding: occasional
Slope range: 0 to 2 percent
Elevation: 950 to 1,550 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Why soil and similar soils: 60 percent
Brios soil and similar soils: 30 percent
Contrasting inclusions: 10 percent

Typical Profile

Why

0 to 12 inches—very pale brown and light brown, stratified coarse sand and coarse sandy loam
12 to 60 inches—light brown and very pale brown, stratified gravelly coarse sandy loam and coarse sandy loam

Brios

0 to 12 inches—light yellowish brown, coarse sandy loam
12 to 60 inches—very pale brown and yellowish brown, stratified loamy coarse sand and gravelly coarse sand.

Soil Properties and Qualities

Why

Parent material: fan alluvium
Depth class: very deep
Drainage class: somewhat excessively
Permeability: moderately rapid
Available water capacity: moderate
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: very high

Brios

Parent material: fan alluvium
Depth class: very deep
Drainage class: excessively
Permeability: rapid
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—low
Hazard of water erosion: slight
Hazard of wind erosion: high

Inclusions

Contrasting inclusions:
• Very gravelly soils (Carrizo).
• Saline-sodic soils on the distal portion of the map unit in the vicinity of the Sierra Estrella and San Tan Mountains.
Similar inclusions:
• Soils that have surface textures of gravelly sandy loam, gravelly loamy coarse sand, gravelly sand, loamy coarse sand, and coarse sand.

Use and Management

Rangeland

Dominant vegetation on the Why soil:
• Potential plant community—big galleta, bush muhly, littleleaf paloverde, ironwood
• Present plant community—creosotebush mesquite, triangle bursage, wolfberry, annual forbs and grasses
Dominant vegetation on the Brios soil:
• Potential plant community—blue paloverde, littleleaf paloverde, big galleta
• Present plant community—creosotebush, mesquite, triangle bursage, wolfberry, annual forbs, grasses
Important forage species: bush muhly and big galleta
Major management factors: flooding, droughtiness
General management considerations on the Why-Brios soils:
• This unit is among the most productive in the survey area.
• Potential vegetation is dominated by perennial grasses, desert shrubs, and trees.
• This unit benefits from run-on moisture, which increases the amount of forage produced.
• Livestock movement is hindered by dense, brushy growth.
• This unit has shade for livestock.
• Livestock will generally overgraze this area, unless controlled, because of the availability of water and abundance of feed.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this unit from erosion.

Suitable management practices on the Why-Brios soils:
• Thin trees to encourage production of perennial grasses.
• Provide erosion protection if the plant cover is disturbed.
• Seeding can be used to improve range condition when there are not enough remnant perennial grasses to reestablish the site.
• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Prevent overgrazing of this unit by fencing or controlling water availability.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Wildlife Habitat

Suitability of the Why-Brios soils for desertic herbaceous plants and desertic shrubs and trees: moderately well suited

Interpretive Groups

Land capability classification:
Why soil—IIIw irrigated, VIIw nonirrigated
Brios soil—IVw irrigated, VIIw nonirrigated
Range site:
Why soil—Sandy Bottom, 7- to 10-inch precipitation zone
Brios soil—Sandy Bottom, 7- to 10-inch precipitation zone

37—Yahana-Indio complex, saline-sodic, 0 to 3 percent slopes

Setting

Landform: flood plains
Landscape position: lowlands adjacent to the Gila River
Flooding: rare
Slope range: 0 to 3 percent
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Yahana soil and similar soils: 75 percent
Indio soil and similar soils: 15 percent
Contrasting inclusions: 10 percent

Typical Profile

Yahana

Surface covered by a 2-5 mm thick white salt crust
0 to 2 inches—light yellowish brown, saline and sodic, silt loam
2 to 60 inches—brown and pale brown, stratified, saline and sodic, loam, silt loam and silty clay loam

Indio

0 to 4 inches—light yellowish brown, saline and sodic, very fine sandy loam
4 to 17 inches—light brown, saline and sodic, loam
17 to 60 inches—light brown, stratified, saline and sodic, very fine sandy loam and silt loam

Soil Properties and Qualities

Yahana

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: high
Corrosivity: steel—high; concrete—high
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Indio

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: moderately slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: low
Corrosivity: steel—high; concrete—high
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
• Sandy soils (Rositas, Vint).
• Clayey soils (Gadsden).

• Soils that have silty clay loam over sand at moderate depths.
• Slickspots that pond water for short periods of time.
• Soils that have limy subsoils (Casa Grande).
Similar inclusions:
• Soils that have surface textures of loamy fine sand, fine sandy loam, loam and silty clay loam.
• Areas that have slopes ranging to 5 percent.
• Soils that are gravelly or very gravelly throughout.
• Soils similar to Yahana with less salt and sodium (Glenbar).

Use and Management

Rangeland

Dominant vegetation on the Yahana soil:
• Potential plant community—Torrey seepweed, thinleaf fourwing saltbush, iodine bush, black greasewood
• Present plant community—seepweed, desert saltbush, mesquite, wolfberry
Dominant vegetation on the Indio soil:
• Potential plant community—desert saltbush, thinleaf fourwing saltbush, mesquite
• Present plant community—seepweed, desert saltbush, mesquite, wolfberry
Important forage species: evergreen saltbush browse
Major management factors: flooding, salinity, sodicity
General management considerations on the Yahana soil:
• This soil is among the least productive in the survey area.
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this soil is limited by saline-sodic conditions.
• This soil is easily traversed by livestock.
• Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from erosion.
• Avoid grazing this soil during the spring because of the availability of black greasewood, a plant toxic to livestock.
• Salt is generally not needed on this soil because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices on the Yahana soil:
• Use water-spreading dikes to increase the area that benefits from run-on moisture.
• Encourage uniform grazing on this soil by developing and controlling permanent waters.
• Concentrate management on included soils in the drainageways where the majority of forage is produced.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.
General management considerations on the Indio soil:
• Potential vegetation is dominated by salt-tolerant shrubs.
• Production on this soil is limited by saline-sodic conditions.
• This soil is easily traversed by livestock.
• This soil has shade for livestock.
• Proper grazing distribution is difficult on this soil because of the unavailability of permanent water.
• Overgrazing reduces the plant cover and increases the rate of erosion.
• Extra care in management is needed to protect this soil from erosion.
• Salt is generally not needed on this soil because the available browse contains salt.
• When annuals are not available, the energy requirements of livestock will not be met by the available forage.
Suitable management practices on the Indio soil:
• Encourage uniform grazing on this soil by developing and controlling permanent waters.
• Provide a protein supplement when annuals are not available.
• Control erosion and promote forage production with proper utilization.
• Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity
General management considerations:
• Intensive management is needed to reduce the salinity and sodicity of this unit.
• For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
• The quality of irrigation water is an important consideration prior to and during reclamation.
• Water can be distributed by lined ditches or pipelines.
• High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.

Suitable management practices:
• Salt-tolerant crops should be selected for planting during reclamation.
• During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
• Adding soil amendments and leaching helps reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by a soil test.
• To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
• Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
• After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
• Irrigation water can be applied efficiently by using sprinkler, drip, border, or furrow irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field to a basin system may be prohibitive. A graded system is more feasible in those areas.
• Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
• Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
• Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
• The risk of flooding can be reduced by the use of dikes and diversions.

Building Site Development

Major management factors: low strength, hazard of flooding, salinity, sodicity, corrosion hazard
General management considerations:
• Excavation can expose soil material that is highly susceptible to wind erosion.
• Excavation increases the risk of water erosion.
• The quality of roadbeds and road surfaces can be adversely affected by limited soil strength.
• Septic tank absorption fields can be expected to function poorly because of wetness in some areas during periods of flooding.
• Onsite investigation is needed to determine whether the area considered for a septic tank absorption field is of acceptable material.
Suitable management practices:
• Reduce the risk of flooding by constructing dikes and channels that have outlets for floodwater.
• Revegetate disturbed areas at construction sites as soon as possible to reduce the hazard of wind erosion.
• Select salt- and sodium-tolerant plants for landscaping.
• Design buildings and roads to offset the limited ability of the soil to support a load.
• Offset the risk of corrosion to uncoated steel and concrete by using treated steel pipe and sulphate-resistant cement.
• Seed road cuts and fills to permanent vegetation.

Wildlife Habitat

Suitability of the Yahana soil for desertic herbaceous plants and desertic shrubs and trees: very poorly suited
Suitability for the Indio soil for desertic herbaceous plants and desertic shrubs and trees: poorly suited
Suitability of the Yahana soil for irrigated grain and seed crops and irrigated domestic grasses and legumes: poorly suited
Suitability of the Indio soil for irrigated grain and seed crops and irrigated domestic grasses and legumes: moderately well suited

Interpretive Groups

Land capability classification:
Yahana soil—IIs irrigated, VIIs nonirrigated
Indio soil—IIs irrigated, VIIs nonirrigated
Range site:
Yahana soil—Alkali Flat, 7- to 10-inch precipitation zone
Indio soil—Saline Loam, 7- to 10-inch precipitation zone

38—Yahana silty clay loam, 0 to 2 percent slopes

Setting

Landform: flood plains
Landscape position: lowlands adjacent to the Gila River
Flooding: rare
Elevation: 940 to 1,400 feet
Mean annual precipitation: 7 to 10 inches
Mean annual air temperature: 69 to 73 degrees F
Frost-free period: 240 to 280 days

Composition

Yahana soil and similar soils: 75 percent
Contrasting inclusions: 25 percent

Typical Profile

Surface covered with a 2-5 mm thick white salt crust
0 to 4 inches—brown, saline and sodic, silty clay loam
4 to 14 inches—brown and strong brown, stratified saline and sodic, silty clay
14 to 58 inches—light brown and light yellowish brown, mottled, stratified saline and sodic, silty clay, silty clay loam and silt loam
58 to 60 inches—light yellowish brown, mottled, saline and sodic, loamy fine sand

Soil Properties and Qualities

Parent material: stream alluvium
Depth class: very deep
Drainage class: well
Permeability: slow
Available water capacity: very low
Potential rooting depth: 60 or more inches
Runoff: slow
Shrink-swell potential: high
Corrosivity: concrete—high; steel—high
Hazard of water erosion: moderate
Hazard of wind erosion: moderate
Salinity: strong
Sodicity: strong

Inclusions

Contrasting inclusions:
- Soils that are finer textured (Gadsden).
- Soils that are coarser textured (Indio, Vint).
- Soils that are underlain by sand at moderate depths.
- Areas of 3- to 8-foot deep gullies.
- Slickspots

Similar inclusions:
- Soils that have surface textures of very fine sand, loamy fine sand, very fine sandy loam, silt loam, or silty clay.
- Areas of slopes ranging to 7 percent.

Use and Management

Rangeland

Dominant vegetation:
- Potential plant community—Torrey seepweed, thinleaf fourwing saltbush, iodinebush, black greasewood, inland saltgrass
- Present plant community—Torrey seepweed, iodinebush, greasewood, thinleaf fourwing saltbush

Important forage species: evergreen saltbush browse
Major management factors: flooding, salinity, sodicity
General management considerations:
- This unit is among the least productive in the survey area.
- Potential vegetation is dominated by salt-tolerant shrubs.
- Production on this site is limited by saline-sodic soils.
- This unit is easily traversed by livestock.
- Proper grazing distribution is difficult on this site because of the unavailability of permanent water.
- Overgrazing reduces the plant cover and increases the rate of erosion.
- Extra care in management is needed to protect this unit from erosion.
- Avoid grazing this unit during the spring because of the availability of black greasewood, a plant toxic to livestock.
- Salt is generally not needed on this unit because the available browse contains salt.
- When annuals are not available, the energy requirements of livestock will not be met by the available forage.

Suitable management practices:
- Use water-spreading dikes to increase the area that benefits from run-on moisture.
- Encourage uniform grazing on this unit by developing and controlling permanent waters.
- Concentrate management on included soils in the drainageways where the majority of forage is produced.
- Provide a protein supplement when annuals are not available.
- Control erosion and promote forage production with proper utilization.
- Provide periodic rest during the growing season to maintain plant vigor and production.

Cropland

Major management factors: droughtiness, salinity, sodicity
General management considerations:
- Intensive management is needed to reduce the salinity and sodicity of this unit.
- For the efficient application and removal of irrigation water, leveling is needed in sloping areas.
- The quality of irrigation water is an important consideration prior to and during reclamation.
- Water can be distributed by concrete-lined ditches or pipelines.
- High salinity and sodicity restrict the choice of crops. Crop yields and crop selection will improve as salt and sodium are leached.
- The available water capacity is for natural conditions. The available water capacity for irrigated conditions

will vary depending on the degree of reclamation and management of salt and sodium. Onsite soil tests are recommended to provide better estimates of the available water capacity.

Suitable management practices:

- Salt-tolerant crops should be selected for planting during reclamation.
- During reclamation, it is important to promote rapid seed germination because of high salt concentrations in the seedbed area. This is achieved by selecting suitable planting practices, bed shapes, and irrigation management.
- Adding soil amendments and leaching helps reduce the content of toxic salts and sodium. Suitable soil amendments are sulfur, gypsum, and sulfuric acid. The proper kind and amount of amendments needed should be determined by a soil test.
- To prevent a recurrent accumulation of salts when using low-quality irrigation water, an additional increment of water over and above that required to meet evapotranspiration must be passed through the root zone.
- Proper management requires periodic measurement of the salinity and sodicity of the soil to confirm the adequacy of the irrigation practices.
- After reclamation, organic matter content, soil tilth, water intake rate, and other factors of soil condition can be maintained or improved by returning crop residue and adding manure to the soil.
- Irrigation water can be applied efficiently by using sprinkler, trickle, or surface (border or furrow) irrigation systems. In the more sloping areas, the amount of soil that must be moved to level a field for the basin method may be prohibitive. A system with a gradient is more feasible in those areas.
- Onsite investigation is advisable before irrigation systems are planned and cuts for leveling are made.
- Line ditches with Type-5 concrete or install pipelines to eliminate loss of water.
- Keeping the soil rough and cloddy when it is not protected by vegetation or crop residue helps reduce wind erosion.
- The risk of flooding can be reduced by the use of dikes and diversions.

Wildlife Habitat

Suitability for desertic herbaceous plants and desertic shrubs and trees: very poorly suited

Suitability of irrigated grain and seed crops and irrigated domestic grasses and legumes: poorly suited

Interpretive Groups

Land capability classification: IIs irrigated, VIIs nonirrigated

Range site: Alkali Flat, 7- to 10-inch precipitation zone

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Irrigated Crops

This section discusses general soil, water, and crop management needed for irrigated crops. It identifies the major crops grown in the area, explains the system of land capability classification used by the Natural Resources Conservation Service, and lists the estimated yields of the main crops for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

About 32,000 acres in this survey area are presently being used as irrigated cropland. An additional 36,000 acres are idle. The major crops include cotton, alfalfa, wheat, and barley. Minor crops include lettuce, watermelons, sesame, okra, pistachio, spirulina, and guayule. The following information on soil management, water management, and crop management should be used with the map unit descriptions. Also included are tables which give valuable information on features affecting reclamation. Many of the soils are naturally saline-sodic. Reclamation and salt management are necessary to bring these soils into production and to keep the existing cropland producing on a long-term basis.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forest land, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 31,335 acres, or nearly 8.4 percent of the survey area, would meet the requirement for prime farmland if an adequate and dependable supply of irrigation water were available.

A recent trend in land use in some parts of the survey area has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. On some soils included in the list, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Soil Management

Steven Revie, district conservationist, Natural Resources Conservation Service, helped to prepare this subsection.

The physical condition of the soil limits or enhances its ability to produce a profitable crop. In some cases, continued loss of topsoil through erosion can severely limit production. Irrigating crops with saline-sodic water without using proper irrigation techniques can also reduce the productive capacity of soils through accumulation of toxic salts within the root zone.

Good soil condition exists when water, air, plant roots, and microorganisms can move freely through and within the root zone of the soil. The soil has good tilth and no compacted layers. Such farming techniques as numerous tillage operations, single crop production, and excessive use of heavy equipment can destroy soil tilth and create compacted layers.

Good soil condition also depends on the return or addition of adequate amounts of organic material to the soil. The soils of the survey area are subject to high temperatures which cause rapid oxidation and loss of organic material when soil moisture is adequate. Most soils typically contain less than 1 percent organic matter. Exceptions are those soils in the San Carlos irrigation project whose surface layers can range from 1 to 2 percent organic matter.

Crop production cannot be sustained unless organic matter is incorporated into the soil. Organic matter increases the amount of water and nutrients the soil can hold. Growing high-residue crops, such as small grains, and turning the residues into the soil increases the organic matter in the soil so it can hold more water and nutrients. Organic matter improves the soil's structure or tilth. This is very beneficial in saline-sodic soils.

As organic matter breaks down, it releases weak organic acids. These acids help to neutralize the naturally alkaline soils. Many plant nutrients are tied up in alkaline soils. The organic acids help to release them for plant use. Crop residues, gin trash, and manure are the most common sources of organic matter. Adding very large amounts of manure, over 30 tons per acre annually, can cause salt to build up in the soil.

Erosion occurs in localized areas of concentrated water flow or during frequent dust storms associated with summer thunderstorms.

Water erosion typically occurs as sheet, rill or gully erosion. In sheet erosion, the most biologically active layer of the soil, known as topsoil, is removed and usually deposited somewhere downstream from the source. This continued process can severely limit soil productivity if allowed to continue. Rill and gully erosion are more readily seen than sheet erosion. They also remove topsoil, and reduce the ability of the land to be farmed.

Wind erosion, or soil blowing, reduces soil productivity by removing topsoil. Soil-laden wind is abrasive and can severely damage crop seedlings.

Depending on site conditions, soil erosion may be controlled by cultural practices, structural practices, or a combination of both.

Cultural Conservation Practices

Soil erosion is less likely to occur on soils that are in good physical condition. Moisture more readily enters soils that have good tilth, which reduces the runoff that causes water erosion. A high content of organic matter also helps bind soil particles together, making it harder for them to be dislodged and transported by wind.

The cover provided by growing crops also protects the soil from wind and water erosion. Cover reduces "splash erosion" (i.e. the impact of raindrops on the soil surface). Plant cover intercepts raindrops, significantly reducing their energy and allowing them to enter the soil. Cover also reduces wind velocities at the soil surface, reducing the hazard of wind erosion. Conservation practices used to maintain or improve soil condition add organic material to the soil and/or reduce tillage operations. The most common of these practices are conservation cropping sequence, crop residue use, and conservation tillage.

A conservation cropping sequence is the practice of rotating crops and/or growing crops in combination to produce an economic return and maintain or improve soil condition. Application of a good cropping system helps maintain or improve the physical condition of the soil by maintaining organic matter levels in the soil. Rotating the kinds of crops grown on a field also helps control weeds, insects, and diseases by disrupting reproductive cycles or allowing the use of different pesticides. High-residue-producing crops should be included in crop rotations to maintain organic material levels that will promote good soil condition. Small grain and grain sorghum are examples of crops that produce large amounts of residues per unit of yield. Vegetables on the other hand are low-residue-producing crops.

Crop residue use is the practice of returning plant residues to the soil. Since soils require organic material for good physical condition, removal of crop residue is usually not recommended. Residues high in cellulose, such as wheat straw, may require additional amounts of nitrogen fertilizer to aid in decomposition. This also helps assure adequate nitrogen for growing crops by offsetting nitrogen that is not available for plant use during biological breakdown of cellulose. If high-residue-producing crops cannot be economically grown, organic material produced elsewhere can be applied to the soil Mulching is commonly used to maintain good soil condition while growing crops of higher economic value. Mulches added to the soil are usually incorporated in the soil surface.

Conservation tillage may be necessary to avoid creating or amplifying soil-related limitations and hazards. This practice limits tillage operations to those that are properly timed and essential to produce a crop without damaging the soil. Limiting tillage operations helps reduce deterioration of soil structure; reduces soil compaction and formation of tillage pans; and also improves soil aeration, permeability, and tilth.

Soils that have compacted layers must often be mechanically renovated by ripping or subsoiling to shatter the compacted zones. This, however, is only a temporary solution. Once these layers or zones are broken up, conservation cropping sequence, crop residue use, and conservation tillage should be applied to maintain good soil condition.

Every tillage operation must serve a specific need. Ripping, for example, is done to break up a compacted layer or natural restrictive layer. Determine how deep the restrictive layer is before ripping. Check your progress occasionally to determine effectiveness.

A wet soil is easier to work than a dry soil. It also compacts more easily. Tillage should be done when the soil is as dry as possible. Reviving a soil that was worked too wet takes a lot of unnecessary time and effort. Conservation tillage is a money- and soil-saving conservation practice which reduces the number of trips across the field.

Windbreaks are strips of trees and shrubs located around field boundaries. They form barriers that effectively reduce wind velocities in the field they protect. Windbreaks not only reduce wind erosion, they also help maintain a better environment for early crop growth. Harvest may also be improved as wind damage caused by lodging is reduced. Windbreak plants tend to use soil moisture from adjacent crops if not properly managed.

Structural Conservation Practices

The structural practices most often needed in the survey area are diversions and waterways. These practices are often expensive to install but are usually necessary to protect the resource base.

A diversion is a channel, having a supporting ridge on the lower side, constructed across a slope. It diverts water from areas of excess runoff to sites where the water can be used or disposed of without creating an erosion problem. These diversions are needed in areas where frequent storm flows occur to protect fields from flooding. Most fields in the survey area are protected by some type of diversion, but the release of runoff is not always on sites where erosion can be controlled.

Waterways are necessary as erosion control measures when no safe outlet exists for a diversion. A waterway is a natural or constructed channel that is shaped or graded to transport storm flows without eroding. There are several locations in the survey area where channels are eroding because water is too concentrated to be transported safely down the slope. Waterways should be lined or established to suitable vegetation to prevent erosion. Grassed waterways installed in the survey area must be irrigated to maintain a suitable stand of vegetation. These areas may also be used as pasture, hayland, or to provide wildlife habitat.

Characteristics, Reclamation, and Management of Saline-Sodic Soils

Philip D. Camp, soil scientist, Natural Resources Conservation Service, helped to prepare this subsection.

Salinization of soils results when inadequate moisture and/or inadequate soil drainage prevent the removal of naturally occurring or introduced salt compounds. The accumulation of these salts adversely affects the productive potential of thousands of acres of land in the survey area.

To discuss these soils, it is convenient to use terms that refer specifically to the two principal causes of the problem. Saline soils, as used in this section, are soils that contain sufficient soluble salts to impair productivity. Similarly, sodic soils can be defined in terms of productivity loss as influenced by excess sodium. Soils that contain an excess of both soluble salts and sodium are referred to as saline-sodic soils.

A saline soil is one that has an electrical conductivity (ECe) of the saturation extract of more than 4 decisiemens per meter (dS/m) at 25 degrees C and a sodium adsorption ratio (SAR) of less than 13. Ordinarily the pH of the saturated soil paste is less than 8.2. Saline soils can be recognized by the accumulation of white salts on the surface. These salts are readily soluble. The principal cations are sodium (which seldom makes up greater than half of the total), calcium, and magnesium. The potassium content is usually low. The chief anions are chloride and sulphate with lesser amounts of nitrate and bicarbonate. Soluble carbonate is rarely present.

The surface soil is usually loose and well flocculated, allowing for rapid infiltration of applied water, at least until the soluble salt in the surface is removed by leaching.

A sodic soil is one which has an SAR of greater than 13 and an ECe of less than 4 dS/m. The pH of the saturated soil paste is usually greater than 8.5 and may reach 10 or more. These soils are often called "black alkali" because the contained organic matter, soluble in the highly alkaline soil solution, is dispersed and accumulates on the soil surface by capillary movement. The high SAR of these sodic soils causes them to lose their granular structure.

They become almost impervious to water and air, because of the destruction of soil aggregates responsible for the presence of large pores. Root penetration is impeded, clods are hard, and it becomes difficult to prepare a good seedbed. Poor germination and uneven stands also frequently occur as a result of surface crusting.

Sodic soils, through their poor physical properties, reduce crop growth. However, the nutrition of some plants such as tree fruits, vines, and a few annuals, can be affected by excess sodium before the physical properties of the soil have deteriorated significantly.

The soil solution of sodic soils is relatively low in soluble salts. The anions consist mostly of chlorides, sulphates, and bicarbonates, and a small amount of carbonates may be present. The presence of carbonate ions causes precipitation of calcium and magnesium. The calcium and bicarbonate ions can only exist together in dilute solutions. Upon concentration, calcium carbonate is precipitated. A similar reaction occurs with magnesium. These reactions further increase the ratio of sodium to calcium and magnesium (SAR) in the soil solution.

As bicarbonate becomes concentrated in the soil solution, it can also remove calcium and magnesium from the cation exchange complex, precipitate them, and replace them with sodium ions. This further degrades the soil. Sodic soils commonly have an SAR much greater than 13.

Saline-sodic soils are both saline and sodic. They have an ECe greater than 4 and an SAR greater than 13. Their physical properties are similar to saline soils so long as excess salts are present. As soon as these soils are irrigated and the soluble salt content of the surface horizon is reduced to a low level, they can become similar to sodic soils *(46)*.

Saline and sodic soils occur for the most part in regions of arid or semiarid climate. Although weathering of primary minerals is the indirect source of nearly all soluble salts, there are probably few instances where sufficient salts have accumulated in place from this source alone. Saline soils usually occur in areas that receive salts from other locations, and water is the primary carrier *(50)*. In this survey area, the direct source of salts is surface and ground water. Constricted drainage in the west end of the community and a perennial influx of drainage water from the Gila River, plus seasonal contributions from the Santa Cruz and Vekol drainageways, contributed to the presence of a high ground water table throughout much of the area. Under such conditions and over long periods of time, upward movement of saline ground water and evaporation of surface water resulted in the formation of extensive salt effected soils. With increased salinity came reduced permeability that further concentrated salts and sodium and impeded the movement of water out of the area.

Crop production is reduced when excessive dissolved salts occur in soils, apparently because plant bio-energy that would otherwise be used in biomass production is expended to produce a negative osmotic potential in order to extract water from the saline soil solution. Less frequently, growth may be reduced as a result of specific nutritional imbalances or ion toxicities when certain salt constituents are individually in excess rather than mixed.

Slow water penetration is a common problem in soils affected by salt and sodium. Sodic soils, because they have a high SAR, are dispersed and therefore have exceedingly low rates of water infiltration and internal transmission. Saline-sodic soils generally have adequate water penetration. When these soils irrigated, the soluble salts are readily leached and the remaining sodium disperses the soil particles, dramatically reducing water penetration. Infiltration rates that approach zero are common. Methods to maintain a favorable salt and sodium ratio are critical during reclamation.

Soils that are excessively saline usually take in water at an adequate rate, but if the irrigation water has a low salt content, the salinity of the surface soil is reduced rapidly and slow water penetration usually follows. Caution should be exercised to avoid confusion between the effects of low soil fertility and those caused by salinity. Plants that are stunted because of low fertility are usually yellowish green, whereas those stunted because of salinity are characteristically blue green.

The only practical and proven method of reclaiming salt-affected soils is by leaching with water. For reclaiming sodic soils, however, an amendment or deep tillage may be required before leaching. Soils excessively high in boron are particularly difficult to reclaim because of the tenacity with which boron is held. Adequate drainage is essential for reclamation. Natural internal drainage alone may be adequate. Where such natural drainage is lacking, an artificial system must be provided or reclamation will not be feasible.

To reduce excess soluble salts in a saline soil, lower-salinity water must be passed through the active root zone depth of the soil. The amount of leaching required to reclaim saline soils is a function of the initial level of soil salinity, of the ultimate level desired and the depth of soil to be reclaimed (which are largely determined by the crops to be grown), and of certain soil and field properties and the method of water application (which influence leaching efficiency). A simple, direct way to determine the amount of leaching required for saline soil reclamation for a particular field and water application method is to initiate leaching of a test site by the intended method and monitor the change in soil salinity. Leaching efficiencies are generally quite high in porous soils. In structural soils and soils with increasing clay contents, leaching efficiencies tend to drop because water moves preferentially through the large soil pores relative to the small pores within the soil *(23, 52)*.

Reclamation can be enhanced by the presence of plants, although some leaching must occur before even a salt-tolerant crop can be grown when soil salinity is extremely high. The beneficial effects of plants are not well understood, but they are probably due to the physical action of plant roots, the addition of organic matter, and the increased dissolution of lime in the presence of carbon dioxide evolved from decomposition of organic matter and plant root respiration. Removal of salts by crop harvesting is not an effective method for removing salt from soil. Crops generally remove less than 5 percent of the amount of soluble salts present in the root zone and less than the amount which normally would be applied in the irrigation water to meet evaporation needs *(17)*.

Visible crusts of salt on the soil surface have sometimes led to attempts to reclaim saline soils by surface flushing. Flushing is the passing of water over the soil surface and wasting the runoff. All known tests of the flushing method fail to show that it is effective *(35)*.

The detrimental effects of high levels of sodium (reduced soil permeability and sodium "toxicity") are not expressed in the presence of high salinity. In most cases, excessive sodium in saline-sodic soils is sufficiently reduced during leaching that no special reclamation procedures are required *(29,30,18)*. This automatic removal of excessive sodium with leaching of saline-sodic soils occurs because they typically contain sufficient precipitated calcium carbonate and calcium sulphate, as well as soluble calcium, to exchange with absorbed sodium during leaching.

Reclamation of sodic soils by leaching without amendments is normally not recommended, unless the leaching water is sufficiently saline to promote infiltration into the soil. Such soils readily lose their permeability when leached with low electrolyte water *(34)*. The reclamation of sodic soils generally requires the incorporation of a relatively soluble calcium-producing amendment in the topsoil prior to leaching. To achieve reclamation the applied water must infiltrate and dissolve the calcium-supplying amendment, bring the calcium into contact with the sodium, and leach away the replaced sodium, all in a practical period of time. Infiltration rates will not be sufficient to achieve these requirements if the electrolyte concentration of the infiltrating water is too low to maintain soil structural stability in the topsoil *(37)*.

In many cases, the electrolyte level of the infiltrating water will have to be raised by application of some soluble salt, like gypsum, to the water or topsoil before leaching is initiated. For some cases, gypsum solubility may be insufficient for this need and a more soluble amendment, such as calcium chloride or sulfuric acid, may be required. Evaluation of the adequacy of the soils permeability to the anticipated leaching water, both with and without the selected amendment, should be undertaken before reclamation. Again, such evaluations can be carried out in small field trials or in laboratory column studies *(37)*.

The kind and amount of amendment for reclaiming sodic soils depend on the physical and chemical properties of the soil, the desired rate of reclamation, the extent of sodium replacement needed, the amount and quality of water available for leaching, drainage capacity of the soil, cost for amendments and water, and time out of production. Common soil amendments for reclaiming sodic soils are listed on the following chart.

Amendment	Chemical Composition	Physical Description
Gypsum	$CaS0_4$ $2H_20$	white mineral
Sulphur	S_8	yellow element
Sulfuric acid	H_2SO_4	corrosive liquid
Lime sulfur	9% Ca + 24% S	yellow-brown solution
Calcium carbonate	$CaCO_3$	white mineral
Calcium chloride	$CaCl_2$ $2H_20$	white salt
Ferrous sulfate	$FeSO_4$ $7H_20$	blue-green salt
Pyrite	FeS_2	yellow-black mineral
Ferric sulfate	$Fe_2(SO_4)^3$ $9H_2O$	yellow-brown salt
Aluminum sulfate material	$Al_2(SO_4)^3$ $18H_2O$	corrosive granular

Gypsum is the most commonly used amendment for sodic soil reclamation, because of its low cost and availability. Because calcium sulfate has relatively low solubility, it is relatively slow acting, compared to amendments like sulfuric acid and calcium chloride *(31)*. Thus, if gypsum is used for reclamation, reclamation cannot normally be achieved in a single leaching because of its limited solubility and the low permeability of sodic soils. Calcium chloride is very soluble and produces a leaching solution of high electrolyte concentration, which promotes increased water intake and speeds reclamation *(1, 22, 11)*; but it is very expensive.

Sulfuric acid has been shown to be effective for reclaiming sodic, calcareous soils. This acid reacts with soil calcium to produce gypsum. It promotes flocculation and aggregation. It is quite costly, unless it is obtainable close-by as a waste product of mining or industry. Sulfuric acid is dangerous and requires special handling and application equipment. Spot applications of sulfuric acid have been effective on "hot spots" within some reclaimed fields in the survey area.

The most important factor to consider in selecting an amendment is its ability to increase or maintain soil permeability sufficiently to achieve reclamation in a practical period of time. The next consideration is whether the soil contains sufficient calcium carbonate to permit use of an acid-forming amendment. Time and economics of alternative amendments are usually the next most important factors to consider *(37)*.

Following reclamation, the level of the various salt constituents of concern (salinity and sodicity) must be kept below allowable limits. If the planned crop and water management practices are expected to result in excessive salinity or sodicity, alternative management practices must be selected, such as a change in quality of irrigation water, selection of a more salt-tolerant crop, or increase in leaching fraction. Proper management also requires periodic measurement of the salinity and sodicity status of the soil to confirm the adequacy of the irrigation and drainage practices. A crop that can tolerate the salinity conditions within the root zone should be selected and special care taken to keep conditions as optimum as possible during the germination and seedling periods. Frequently, the outcome of the entire season is set by the stand established. Thereafter, irrigation must be given frequently enough to assure that sufficient available water is present within the active root zone in accordance with crop needs, especially during critical periods of plant development and to achieve the leaching requirement for salinity control. One should recognize that soluble salts in soil water reduce water availability to plants *(37)*.

The proper operation of a viable, permanent irrigated agriculture requires periodic information on concentrations and distributions of soil salinity within the fields. Salt concentration within the root zone must be kept from reaching excessive levels, but gross salt balance evaluations or tests on a large scale are useless for assessing the changes in root zone salinity, the adequacy of leaching, and drainage practices, or facilities, of irrigated lands *(36, 19)*. Direct monitoring of root zone salinity is required to evaluate the effectiveness of various management programs.

Irrigation scheduling and water management on salt-affected soils requires additional considerations. Irrigation scheduling methods based solely on measurements of soil water content are inadequate where salinity is present because of the added osmotic stress which, in turn, also depends upon soil water depletion between irrigations. In areas of saline water, irrigations must be scheduled before the total soil water potential drops below the level which permits the crop to extract sufficient water to sustain its physiologic processes without loss in yield. The frequency of irrigations should be determined by the total soil water potential in the upper root zone where the rate of water depletion is greatest. On the other hand, the amount of water to apply depends on the stage of plant development and the salt tolerance of the crop and, consequently, should be based on the status of the soil water at greater depths. Water must be applied to leach out some of the salts accumulated in the profile to prevent salt concentrations from exceeding tolerable levels. Thus, the amount of water required is dictated by volume of soil reservoir in need of replenishment and level of soil salinity in the lower root zone *(37)*.

Salt tolerance during seed germination may be different than during later stages *(38)*, but in general, crops germinate reasonably well under saline conditions. A major problem, however, is that increased salinity reduces the rate of germination *(39)*. Slowed germination, in turn, delays emergence, which often reduces stand because of increased crusting (through soil drying) and increased disease problems. Another problem is the high salt concentration that often occurs in the seedbed area. For these reasons it is important to promote rapid germination. This is achieved by selecting suitable planting practices, bed shapes, and irrigation water management.

Water Supply and Management

The three main sources of water used for irrigation are surface water, ground water and effluent.

Surface water comes from water released from storage in the San Carlos Reservoir and free flowing water in the San Pedro River. About 90,600 acre-feet per year or one-fourth of the water used for irrigation, is provided by these sources.

Water quality is generally good, with total dissolved solids (TDS) in the 650-800 mg/l (milligrams per liter) range. However, this water is characterized by varying amounts of silt carried in suspension. This water is always sediment-laden, and during periods of heavy runoff on the San Pedro watershed it is referred to locally as "chocolate water." Sediment deposits of up to one-half inch after a single irrigation have been recorded. This is especially damaging to newly germinated plantings, alfalfa in particular. Six to eight inches of silt are deposited in canal systems each year.

Ground water supplies 250,000 acre-feet per year or nearly three-fourths of all irrigation water used. Present pumping lifts range from 100 to 1,200 feet. Water quality in the north central portion of the survey ranges form 2,000 to 5,200 mg/1 TDS. Outside this area, quality ranges from 1,400 to 4,200 mg/l TDS.

A minor source of irrigation water is sewage effluent. Effluent channeled from the Chandler Wastewater Treatment Plant is used for irrigation of 500 to 600 acres in the vicinity of Lone Butte. Quality is about 1,400 mg/l TDS.

Water Quality

San Carlos project irrigation waters typically contain approximately 1 ton of salt per acre-foot and are applied at annual rates of 3 to 5 feet per acre. Thus, from 3 to 5 tons of salt per acre may be added to irrigated soils annually.

To prevent harmful concentrations of salts from building up in the soil following reclamation, an additional increment of water (over and above that to meet crop needs) must be passed through the root zone when irrigating. This is referred to as the leaching requirement.

The leaching requirement increases in direct proportion to the salinity of the irrigation water. Also, the leaching requirement is greater for crops that are more salt sensitive *(4)*.

Sulfuric acid is commonly added to irrigation water at low rates when the sodium to calcium ratio is unfavorable. This will improve infiltration rates on most soils and would be especially beneficial on clayey soils like Gadsden. Sulfuric acid added to the irrigation water will only amend the water. It is not practical to amend or reclaim the soil with this method, since the high concentration of acid needed to achieve necessary benefits would corrode concrete-lined ditches *(45)*.

Irrigation Systems

Several kinds of irrigation systems are presently in use throughout the survey area. Each type of system has its applications and its advantages and disadvantages. The agricultural producer must evaluate each field for soils, crops, irrigation water quantity, and irrigation water quality to select the type of irrigation system that is best adapted to a given set of conditions. Selection of the proper irrigation system depends on economics, soils, and the crops to be grown.

Level basin and level furrow irrigation systems are two of the most efficient methods of irrigation used in the survey area. This type of irrigation applies a known amount of water to a given area as rapidly as is feasible. Water ponds evenly over the entire irrigated area. Leaching can be achieved more effectively and more uniformly with level systems. Soils that are in poor physical condition are also more easily wetted. The level system is adapted to use for all of the commonly grown crops. It is best installed on deep, medium- or fine-textured soils that have slopes of 0.5 percent or less. It is especially well suited to the slower intake soils like Gadsden silty clay loam. Varying water intake rates within a field will distort uniformity of water distribution. Coarse textured soils that take water rapidly limit the length of irrigation run and width of set. Steeper slopes or shallow soils will limit field or bench width. Land leveling is a necessary practice to install level irrigation systems. The development of laser-controlled earthmoving equipment has greatly improved the construction of these systems. All slopes, ridges, and depressions in a field must be eliminated for this type of irrigation system to operate efficiently. Detailed on-site soil investigations should be done prior to land leveling to locate problem soils that may be shallow or too sandy and that will create problems with water distribution after cuts and fills are made.

Graded border and graded furrow irrigation systems can be installed with less manipulation of land surface than level systems. These systems are often used where deep cuts in land leveling operations would expose undesirable soil material. With these systems, water is applied at a rate that slightly exceeds the soil intake rate. Land leveling is necessary to eliminate irregularities in end slope and side slope so that these systems may be operated at maximum efficiency. Water inputs, application time, and soil intake rates must also be monitored during irrigation applications. Construction of a runoff (tailwater) recovery system will save water by allowing runoff to be reused. Leaching or replacing soil moisture in soils that are in poor physical condition can be difficult with graded surface irrigation systems.

Sprinkler systems are best adapted to moderately coarse and coarse textured soils that readily take water. However, they can also be installed and used with minimum landforming. High evaporation rates that are characteristic of the survey area reduce the application efficiency of sprinkler systems. These systems must be properly designed so that crops can be irrigated in successive stages without causing crop stress. Portable sprinkler systems are often used to germinate vegetable crops like lettuce, and once the crop is established, surface irrigation systems are used to meet the crop's water needs.

Drip irrigation is the most efficient of all irrigation systems in delivering a specific amount of water to the crop. These systems can be installed with almost no topsoil disturbance. Drip systems are relatively expensive to install because they require water filtration and underground pipelines. As with other highly efficient irrigation systems, they also required a high level of management to operate properly. This is a relatively new technology, and some management requirements of the system may not yet be recognized. In any case, proper design and installation of the system are essential to obtain the desired results.

Irrigation Water Management

All irrigation systems must be well managed to operate efficiently. Crops may be over-irrigated or under-irrigated if the irrigator does not know how much water he or she is applying or how much needs to be applied to replace water removed from the root zone.

Several methods of measuring the flow of irrigation water are available. It is possible to measure the amount of water being applied at the well, in the ditch, or in the furrows.

Moisture available in the soil may be estimated by the "feel" of the soil, or by one of several devices that measure soil moisture or crop canopy temperature. Regardless of the method used, the amount of water that needs to be replaced in the soil must be known to avoid wasting water by over-irrigating or stressing the crop by under-irrigating. Continuous monitoring of soil moisture levels also helps the manager to know when fields will need irrigating again. Proper scheduling of irrigations usually helps increase crop yields.

Crop Management

A wide variety of crops are grown in the survey area, and many others could be. This subsection describes the management practices under which farmers grow the most important crops.

Alfalfa (Medicago sativa)

Alfalfa is an important part of most cropping systems and is grown for profit as well as soil improvement. The crop is grown throughout the year and can be harvested year-round. The crop that follows alfalfa benefits from its nitrogen fixing ability.

Varieties grown in the area are non-dormant cultivars. The characteristics shared by alfalfas in this group include lack of cold tolerance with little or no winter dormancy, quick recovery after cutting, erect stems, and purple flowers *(51)*. These include Mesa-Sirsa, El-Unico, Sonora-70, Hayden, Moapa-69, VC-Salton, and VC-Cargo *(51)*. An important local characteristic is resistance to the spotted alfalfa aphid and downy mildew.

Eight to ten hay cuttings are normally made each year. Although hay can be harvested throughout the year, hay cut from December through February dries slowly. This lowers the quality of hay produced. To utilize the winter growth, sheep from the northern part of the state are usually trucked in to winter on alfalfa.

The average annual consumptive use of water for alfalfa is about 74 to 80 inches per year *(12)*. The crop is normally irrigated with level basin or graded border irrigation systems. All irrigations should be properly managed to avoid stand depletion. Water standing over the crown for more than 12 hours will kill the plant.

A stand of alfalfa is normally grown for 3 to 4 years and followed by small grains, sorghum or cotton.

Cotton (Gossipium hirsutum and G. barbadense)

Cotton is the principal income-producing crop on most farms. There are several commercial varieties of G. hirsutum (commonly known as extra long staple or Pima cotton), an extra-long staple Egyptian cotton that is also grown in the survey area.

Most cotton is planted in April when mean soil temperatures exceed 60 degrees F.

Graded furrow and level furrow irrigation systems are the most widely used methods of supplying this crop's water needs. Level basin and sprinkler systems are also used to some extent in the survey area. The average annual consumptive use of water by cotton is about 41 inches per acre per year *(12)*.

Cotton is picked from October through December in most years.

Barley (Hardeum volgare) and Wheat (Triticum aestiuum)

Barley and wheat are the winter small grain crops most commonly grown in the area. These crops are planted in rotation with cotton, on newly leveled land, and as intercrops in orchards. The large amounts of crop residues produced by small grains add needed organic matter to the soil. Barley is more tolerant of high salinity levels than wheat and is better adapted for reclamation of saline-sodic soils *(9, 10)*.

These crops are suited to most irrigated soils in the survey area. Variety selection depends on specific site and market conditions. Information on varieties can be obtained from the local Extension Service office.

Small grains are usually grown in level basins or graded borders, but other types of irrigation systems can be used to supply the crop's water needs. The average annual consumptive use of water is about 25 inches for barley and 26 inches for wheat *(12)*. The peak water use period occurs in March and April. Small grains are harvested in May and June.

Salt Tolerance of Plants

Barley and cotton are the most salt-tolerant of the commonly grown crops. These crops that produce full yields at salinities up to 8 dS/m. Wheat has a tolerance of 6 dS/m. Alfalfa and lettuce both have tolerances of 2 dS/m or less. As salinity exceeds these tolerances, yields will decrease proportionately *(4, 21)*.

Some crops are affected by salinity more at one stage of development than another. Usually crops are as tolerant, if not more so, at the germination stage as at later stages. An exception is cotton, which is more sensitive during germination. Other crops, such as barley and wheat, are most sensitive during early seedling growth and then become increasingly tolerant during later stages of growth and development *(21)*. Most crops are more sensitive to salinity under hot, dry conditions than under cool, humid ones *(21, 4)*.

Crops irrigated by sprinkler systems are subject to additional salt damage when the foliage is directly wetted by saline water *(21)*. If sprinkler water is applied and the foliage is subjected to alternate wetting and drying periods, special attention must be paid to both the sodium and chloride concentrations of the irrigation water. When foliage is wetted by sprinkler irrigation, leaves absorb salts directly, and both sodium and chloride may accumulate to toxic levels *(37)*.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good-quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Natural Resources Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(48)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are 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 or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or 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.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

In this survey, the presence of soluble salts or exchangeable sodium, or both, are not considered permanent limitations to use where the removal of these limitations if feasible. "Feasible," as used in this context, means that the characteristics and qualities of the soil are such that it is possible to remove the limitation, and it is within the realm of present-day economic possibility to do so. Soils considered feasible for improvement are classified on the basis of their continuing limitations and hazards as if the correctable limitations had been removed or reduced. Capability groupings are subject to change as new information about the behavior and responses of the soils becomes available.

Rangeland

Steve Barker, range conservationist, and Steve Cassady, district conservationist, Natural Resources Conservation Service, helped to prepare this section.

About 303,000 acres in the soil survey area is rangeland. This survey area lies in Major Land Resource Area 40, the Central Arizona Basin and Range. The subresource area is 40-2, the Phoenix Desert Shrub type. Plant communities are shrub-dominated and have perennial grass understories.

The Phoenix Desert Shrub subresource area averages from 1,000 to 2,000 feet in elevation with the highest peak reaching 4,500 feet. Slopes are mostly level to gently sloping and consist of broad flood plains and low, gently sloping terraces and broad alluvial fans. The mountains rise abruptly from the valley floor and are made up mostly of basalt, granite and schist rock.

Annual precipitation ranges from 7 to 10 inches. Most of the rainfall comes in July and August, and December through February. Average annual temperatures range from 69 to 73 degrees F. The average frost-free period ranges from 240 to 280 days.

Where soils are not affected by salt, major trees and shrubs include littleleaf paloverde, blue paloverde, ironwood, triangle bursage, brittlebush, creosotebush and cactus. Perennial grasses on nonsaline soils include bush muhly, big galleta, slim tridens, and perennial threeawns.

The vegetation on saline-sodic soils is dominated by salt-tolerant shrubs, including desert saltbush, seepweed, black greasewood, thinleaf fourwing saltbush, and wolfberry. Mesquite is the dominant tree. Salt-tolerant perennial grasses include alkali sacaton, inland saltgrass, and twoflower trichloris.

Historic use

This area has a long history of livestock use, especially along the Gila River and its tributaries. A brief review of the history may help explain the present conditions and problems in the area today.

In 1699, Jesuit Missionary Eusebio Kino wrote of the area: "all its inhabitants are fisherman, and have many nets and other tackle with which they fish all the year, sustaining themselves with the abundant fish and with their maize, bean and calabashes." His companion on this visit, Captain Juan Manje, reported sleeping "in a pasture and broad fields, abundant in grass, where our horses ate well." Historical accounts suggest that Kino brought the first livestock to this area and taught the Indians the basics of ranching. In 1744, another Jesuit Missionary, Jacabo Sedelmayr, described the confluence of the Salt and Gila Rivers as being very pleasant, where "the eye is regaled with creeks, marshes, fields of reed grass and an abundant growth of willows and cottonwoods." He also described the area of Maricopa Wells; "We came upon broad savannas of reed grass and clumps of willows, and beautiful springs with good land for pasture" *(33)*.

Beaver trappers were among the first whites to arrive in this area as they traveled into the river valleys of northern and central Arizona in the 1820's. From 1830 to 1840, the number of white travelers increased, as two of the major routes to California passed through this area. One route followed the Gila River from its headwaters in New Mexico. The other route started farther south and went to the Mexican village of Tucson, then came north to the Gila River along the route of today's Interstate 10. The Pima and Maricopa Indians living along the Gila River supplied travelers and troops with livestock and grain as they passed through. From here, some travelers continued to follow the Gila River to Gila Bend and on to the Colorado River, but most went around the south end of the Sierra Estrellas and rejoined the Gila River at Gila Bend. This route shortened the trip by about 90 miles *(8, 33)*.

During the Mexican-American War (1846-48), Lieutenant Colonel William H. Emory wrote of long meadows where the Pima grazed their cattle. A year later, John W. Audubon (youngest son of the famed naturalist) reported finding grass on the light sandy soils of the uplands, "in some places very sparse and thin and in others pretty good" *(33)*.

The U.S. bought the southern portion of Arizona (south of the Gila River) as part of the Gadsden Purchase in 1854. Five years later, on February 28, 1859, the Gila River Indian Reservation was established as the first reservation in Arizona. It wasn't until 1863, however, that President Lincoln signed legislation making Arizona a territory in its own right *(8, 33)*.

From the 1860s to the early 1900s, the Gila River Basin and its tributaries went through a sustained drought. Herbert Brown, an ornithologist in the area at the time wrote "The stock business at one time promised enormous profits and because of this the country is literally grazed to death. During the years 1892 and 1893 Arizona suffered an almost continuous drought, and cattle died by the tens of thousands. From 50 to 90 percent of every herd lay dead on the ranges" *(33)*.

Emerson Stratton worked for eight months at the Butterfield stage stop called Maricopa Wells in 1870. He stated, "all the hay in those days was native, and around the reservation it was brought in by the Indians. At Maricopa Wells, however, we had to get it for ourselves...the best clumps of grass grew around the trees...in those days there were large areas of dead mesquite all over southern Arizona" *(44)*.

In 1887, the entire summer flow of the Gila River was diverted into irrigation canals east of Florence. This left the reservation without water for crops. The Pima and Maricopa Indians had been diverting water out of the river for years. From historical accounts, they had quite an extensive irrigation system. The loss of water was also detrimental to the native vegetation. Drought, overgrazing, beaver trapping, mesquite harvesting, and the diversion of water out of the Gila River had all contributed to the destruction of the Gila river vegetation that the early travelers saw. By 1907, the Gila River channel was broad and unstable, the trees and grasslands having mostly been scoured away *(33)*.

Today, the Gila River bottom produces several hundred pounds of canarygrass and other annuals in wet springs when water runs in the river bottoms. Mesquite and saltcedar dominate the edges of the main channels where underground water is still within reach. Large areas of dead mesquite and old mesquite stumps indicate where the water table was shallow when the Gila ran yearlong.

Cattle still graze along the Gila and its tributaries on the reservation, mostly steers making use of spring annuals. A substantial population of "feral" horses lives yearlong on the reservation, grazing mainly along the Gila River and its tributaries. Control of these animals is needed as part of a total range management program on the reservation.

Range Sites

A range site is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal water table are also important. Following is a brief description of range sites which occur in this survey area.

Alkali Flat

This site occurs on nearly level stream terraces and relict basin floors. The soils are deep, well drained, and have a strongly saline layer within 12 inches of the surface. The soil textures range from silty to clayey.

The potential plant community is dominated by low growing salt-tolerant shrubs. Major shrubs present are Torrey seepweed, thinleaf fourwing saltbush, pickleweed, and black greasewood. Production averages 300 pound/acre/year.

Basalt Hills

This site occurs on steep to very steep basalt hills and low mountains. The steep slopes are covered with basalt cobbles, stones, and boulders. Slopes range from 15 to 60 percent. Soils are shallow and very cobbly on the surface. The soil overlays silica lime pans or bedrock.

The potential plant community is shrub-dominated. The major shrubs and trees present are white brittlebush, littleleaf paloverde, and triangle bursage. Perennial grasses include bush muhly, slim tridens, and big galetta. Production on this site averages 300 pounds/acre/year.

Granitic Hills

This site occurs on steep hills and low mountains. Slopes range from 15 to 75 percent. The soils are shallow and cobbly on the surface. The underlying bedrock is granite and acid igneous rock. Rock outcrop occupies 15 to 30 percent of the area.

The potential plant community is predominantly a shrub site with an understory of perennial and annual grasses and forbs. Major shrubs and trees include littleleaf, paloverde, white brittlebush, and triangle bursage. Perennial grasses include bush muhly, slim tridens, and big galleta. Production averages 400 pounds/acre/year.

Limy Fan

This site occurs as nearly level alluvial fans, and old stream terraces no longer flooded. Slopes range from 1 to 3 percent. The soils are calcareous and moderately droughty.

The potential plant community is a mixture of desert shrubs and cactus with an intermittent understory of perennial and annual grasses and forbs. Major shrubs include creosotebush and triangle bursage. Perennial grasses include bush muhly, big galleta and perennial threeawns. Production averages 300 pounds/acre/year.

Limy Upland

This site occurs as nearly level to moderately sloping old alluvial fans, terraces and bajadas at the base of desert mountains. It also occurs in places as part of the desert plains. Slopes range from 1 to 15 percent. The soils are limy and droughty. Some are underlain at shallow depths with duripans or caliche cemented masses.

The potential plant community is predominantly desert shrubs and cacti. Perennial grass cover is sparse. Creosotebush is the dominant shrub. Perennial grasses include bush muhly and fluffgrass tridens. Production averages 180 pounds/acre/year.

Limy Upland, Deep

This site occurs on fan terraces and their sideslopes. Slopes range from 5 to 15 percent. The soils are deep but are shallow to a layer high in lime. The surface layer ranges from very gravelly loam to very stony sandy loam. The subsoil is mostly extremely gravelly sandy loam. Coarse fragments average 35 to 70 percent of the total soil volume.

The potential plant community is dominated by desert shrubs and cacti. The dominant shrub is creosotebush. Perennial grass cover is sparse. Big galleta, perennial threeawns, and fluffgrass are the major perennial grasses. Production averages 40 pounds/acre/year.

Saline Bottom

This site occurs on nearly level alluvial terraces and plains. The soils are saline and/or sodic and subject to flooding. Slopes range from 0 to 3 percent.

The potential plant community is dominated by grass and grasslike plants with scattered salt-tolerant trees and shrubs. Dominant grasses include alkali sacaton, inland saltgrass, and twoflower trichloris. Shrubs include Torrey seepweed, desert saltbush and fourwing saltbush. Mesquite and saltcedar will invade this site if continuous grazing by livestock is permitted. Production averages 700 pounds/acre/year but can exceed 1,000 pounds/acre/year in good years.

Saline Loam

This site occurs as nearly level to gently sloping stream terraces and relict basin floors. Slopes range from 0 to 5 percent. The soils are deep, well drained, saline-sodic soils. Textures are loamy to clayey within 20 inches of the surface. The surface texture ranges from silt loam to fine sandy loam.

The potential plant community is dominated by salt-tolerant shrubs. The major shrubs present are desert saltbush, thinleaf fourwing saltbush, Anderson wolfberry, and Torrey wolfberry. Perennial grasses include alkali sacaton and twoflower trichloris. Production averages 400 pounds/acre/year.

Saline Sandy Loam

This site occurs as nearly level to gently sloping fan terraces, stream terraces, and relict basin floors. The soils are deep, well drained to somewhat excessively drained, saline-sodic soils. The textures are sandy to loamy with a surface cap of loamy fine sand to sandy loam.

The potential plant community is dominated by salt-tolerant shrubs. Major shrubs present include desert saltbush and thinleaf fourwing saltbush. Anderson wolfberry and mesquite occur in areas benefiting from run-on moisture or where good subsurface moisture is available within 20 to 30 feet of the surface. Perennial grasses include big galleta, twoflower trichloris, and threeawns. Production averages 400 pounds/acre/year.

Sandy Bottom

This site occurs as gently sloping drainageways, washes, fans and strips in the bottoms adjacent to dry washes. Slopes are generally 0 to 3 percent. The soils are deep sandy loams to gravelly sands. These sites are subject to flooding.

The potential plant community is a mixture of perennial grasses and forbs, desert shrubs and trees, and annual grasses and forbs. The active washy areas have little vegetation except burrobrush and annuals. Perennial grasses include bush muhly and big galleta. Dominant shrubs and trees include ironwood, blue paloverde, littleleaf paloverde, seepwillow bacharis, and cottonwood. Production averages 1,500 pounds/acre/year, and may be as high as 2,500 pounds/acre/year in good years.

Sandy Loam Upland

This site occurs as broad alluvial plains that are nearly level. Slopes range from 0 to 3 percent. The soils are deep with a sandy loam cap at least 4 inches thick.

The potential plant community is a mixture of desert shrubs and trees with an understory of perennial grasses. Dominant shrubs include white bursage, triangle bursage, and creosotebush. Trees include littleleaf paloverde and ironwood. Perennial grasses include big galleta and bush muhly. Production averages 650 pounds/acre/year.

Sandy Upland (Saline)

This site occurs an nearly level to moderately steep dunes. Slopes range from 1 to 30 percent. The soils are deep, somewhat excessively drained, and may be slightly saline or sodic.

The potential plant community is a mixture of perennial and annual grasses and forbs and salt-tolerant shrubs. The dominant perennial grass is big galleta. Shrubs include desert saltbush, fourwing saltbush, wolfberry, and black greasewood. Production averages 600 pounds/acre/year.

Shallow Upland

This site occurs as undulating uplands located in and around the low desert mountains. Slopes range from 0 to 15 percent. The soils are shallow, loamy to clayey textured and may be slightly calcareous. They occur over highly weathered granitic bedrock.

The potential plant community is dominated by desert shrubs and cactus, with a thin understory of perennial and annual grasses and forbs. Dominant trees and shrubs include triangle bursage, littleleaf paloverde, and flattop buckwheat. Perennial grasses include big galleta, bush muhly, and threeawns. Production averages 250 pounds/acre/year.

Table 7 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed.

Management

Range management requires a knowledge of the kinds of soil and the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

The areas which have the most potential for improvement in this survey area are the bottoms along the Gila River and its tributaries. The productive capability of these areas is obvious following wet springs when water flows in these bottoms. Where these bottoms will be used as rangeland, fencing and/or water development is needed which will allow these bottoms to be managed separately from the uplands. Without control, the bottoms will be overgrazed because they are easily accessible, water is available, and food is abundant. The bottoms require rest from grazing during the spring and summer growing seasons to allow remnant perennial grasses to reestablish themselves. Seeding is needed when there are not enough remnant perennial grasses to revegetate the site.

Many of the bottom areas and adjacent terraces support, or historically have supported, mesquite bosques or savannas. There is potential for improving or reestablishing mesquite stands in these areas. Water control structures, such as dams and water spreaders, could be used to pond water in the bottom areas, providing the necessary water for mesquite. With selective harvesting, these areas could provide range forage, fuel wood, and excellent wildlife habitat. Table 7 shows those map units in which mesquite is a component of the potential plant community.

Most of the upland rangeland is dominated by salt-tolerant shrubs. Many of these shrubs, such as the saltbush species, will provide yearlong browse for livestock. Although these shrubs will supply the needs for digestible protein, they will not supply the energy requirements of the livestock. This is mainly the result of salt accumulation in many of these species which limits the amount of browse the livestock will consume. This is not a problem during periods when annuals are present to supply the energy requirements. Supplements will normally be required from June to December when annuals are absent. Salt is usually not needed when cattle are using salt-affected areas. If iodine is needed, it can be provided with other supplements.

Grazing management on uplands can be accomplished by carefully selecting locations for water developments and fencing the waters to control access. “Opening” a water allows the area to be grazed. “Closing” a water allows the area to be rested. This method of controlling livestock grazing is generally much more economical than fencing in low rainfall areas. During wet periods, when temporary water is available, livestock may wander away from permanent waters. When this occurs, it is necessary to gather the livestock and relocate them at the permanent water.

The production of annual grasses and forbs in the winter and spring will usually greatly exceed the amount that a yearlong herd can consume. Stocker cattle can be put on temporarily to take advantage of these annuals. The production of annual grasses and forbs varies greatly from year to year, depending on rainfall. An evaluation of these annuals should be made around January to determine the number of animals to turn out. The stocker cattle should be taken off when they begin switching preference from annuals to saltbush or other perennials. All stocker cattle should be removed before use on perennials reaches 30 to 40 percent.

Irrigated pasture can be developed to provide forage, effectively increasing the number of livestock that can be supported yearlong. Using irrigated pastures allows additional flexibility in management by providing a dependable source of forage. This can be used when annuals are not available, or as part of a regular grazing system which provides periodic rest to the rangeland.

Rangeland tables

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 7 shows, for each soil that supports rangeland vegetation suitable for grazing, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. An explanation of the column headings in table 7 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Recreation

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that 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 a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation, such as shaping and leveling the 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 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 campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for 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 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 and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

John C. York, state biologist (retired), Natural Resources Conservation Service, helped to prepare this section.

The ability of an area to produce vegetation determines the kinds and mixes of wildlife that occur on that area. Determining the factors that limit the production of vegetation is one purpose of this soil survey. Since all wildlife depends on vegetation, land managers need to know where they can best manage that vegetation and where their efforts would be wasted. One of the purposes of this survey is to determine if a soil will produce certain kinds of plants and if not, why not?

The kinds, number, and mixes of animals in the survey are determined by conditions that have existed in the past. Animal numbers fluctuate with amounts of moisture in the survey area because vegetation fluctuates with the available moisture. The kinds of animals are relatively fixed (barring major human intervention), and the mixes are determined by the kinds and amounts of vegetation.

Each map unit is rated for its suitability to produce certain categories of vegetation. The rating is based on limiting factors, such as available water capacity, stoniness, shallowness, salinity-sodicity, and hardpans.

The presence or absence of these factors in a particular soil determines what should be growing on that soil. Wildlife habitat is analyzed by determining what a site has supported or should support, what the site is doing at a point in time, and the site's capability to produce in the future.

Vegetative elements of wildlife habitat vary throughout the survey area. Each map unit was rated for its suitability to produce some or all of the following: desert riparian shrubs, trees, vines; desertic herbaceous plants; desert riparian herbaceous plants; desertic trees, shrubs, vines; grain and domestic seed/fiber crops - irrigated; and domestic grasses and legumes - irrigated.

Not all soils were rated for each element, and some elements do not apply to all soils.

Levels of suitability for producing vegetation are assigned each map unit. These suitabilities are expressed as the following ratings:

Well suited means that soil properties are such that vegetation can be easily improved, managed, or established. Limitations are moderate. Some management is necessary to maintain the soil and vegetation.

Moderately well suited means that soil properties allow vegetation to be improved, managed, or established. Limitations are moderate. Management will be necessary to maintain the soil and vegetation.

Poorly suited means that the soil is severely limited in its ability to produce vegetation. Managing for vegetation is possible but establishing vegetation through planting may be very difficult and the potential for success questionable.

Very poorly suited means that the soil properties make it impractical to attempt to establish or improve vegetation. Failure is probable. In a few cases, very intense management may be possible; for example, saline soils can be leached with water..

This rating system compares units to other units in this survey area only. Units rated in this survey cannot be compared to the same soil rated in another survey area unless that survey area is in the same resource area.

Bottom Range Sites (Sandy Bottom) have been rated moderately well suited to well suited. The potential for flooding on these sites promotes vegetation growth. Saline Bottoms are rated poorly suited to very poorly suited. The rough, broken, rocky, basaltic and volcanic mountains and hills are rated moderately well suited to poorly suited. Management can improve this habitat because the rocks and slopes offer protection from grazing. The rocky areas also create more microhabitats for vegetative reproduction. The sandy sites are rated poorly suited. Heavy winter rains, however, will produce very heavy vegetative growth on these soils. If there is no rain, no vegetation is produced. Almost all sites and map units are influenced in some way by moisture that falls into them or runs onto them from adjacent areas. The very poorly suited map units are usually very dry, rocky, saline, shallow and/or have shallow hardpans. Not much can be done with these areas that would be economical or would produce results.

Irrigated cropland will produce some components of habitat. Lettuce, cabbage, carrots, onions, sugarbeets, cotton and similar crops provide little benefit to wildlife. Pesticide use is heavy and few seeds or insects are available. Grain and seed crops provide food. Water is usually available but can be contaminated with pesticides.

Description of the area

The major vegetative communities within the survey area are the Arizona upland and lower Colorado subdivisions of the desertscrub formation. The Arizona upland subdivision is a paloverde-cactus-mixed scrub community which occupies the coarse-textured bajadas and mountain slopes. This community is second only to riparian deciduous communities in diversity of plants and animals. Plants which are usually found are foothill paloverde (Cercidium microphyllum), saguaro (Carnegia giganteus), ironwood (Olneya tesoto), triangle-leaf bursage (Ambrosia deltoidea), ocotillo (Fouquieria splendens), and chainfruit cholla (Opuntia fulgida).

The lower Colorado River subdivision is a creosote-bursage community (Larrea tridentata-Ambrosia dumosa). In addition to this formation, other localized communities occur such as the saltbush (Atriplex spp.) community on the fine textured flood plains of the Santa Cruz and Gila Rivers. Desert saltbush (Atriplex polycarpa) was formerly the most widespread plant community in the bottomlands along the lower Santa Cruz. Agricultural development has removed large areas of desert saltbush.

Riparian scrub is a distinct group of plants with higher moisture requirements than surrounding desert communities. They are found growing along arroyos and large washes in the desert. These plants include whitethorn (Acacia constricta), catclaw (Acacia gregii), mesquite (Prosopis juliflora), and blue paloverde (Cercidium floridum). These washes are pathways affording animals a means to move from one habitat to another. The middle Gila River runs through the reservation from Coolidge to the Phoenix metropolitan area where it is joined by the Salt River. The Santa Cruz River, although it runs only during flood periods, connects with the Gila River near the settlement of Komatke. The confluences of these rivers once formed plant communities that attracted birds and other wildlife.

Most of the original riparian habitat along the rivers, including willows (Salix) and cottonwood (Populus), has been eliminated by drastic reductions in river flows. Much of this habitat has been replaced by saltcedar (Tamarisk). The original mesquite bosques were eliminated by woodcutting, fires, and reductions in river flows. Many of these areas are now barren except for large, dead trees and stumps. Second growth mesquite now occurs on some previously farmed areas that were retired 50 or more years ago. Some riparian habitat exists at the end of canals and tailwater drainages *(5, 7)*.

Wildlife of the survey area

The mammals reported from the survey area are listed. Many of the animals are known to be in the general area, so were listed as "in range." This means that the survey area is within the known range of the animal. Actual collection sites are listed, where known *(6, 20)*.

The reptiles are reported according to the habitat in which they are most likely be found *(43)*.

The birds are reported according to actual documented sightings. It is highly likely that many birds frequenting the survey area have not been reported *(32)*.

Mammals

Bats.—California leafnose bat (in range); cave myotis (in range); California myotis (in range).

Hares.—Antelope jackrabbit (Queen Creek); blacktailed jackrabbit (south of Phoenix).

Rabbits.—Desert cottontail. (17 miles southwest of Phoenix).

Squirrels and allies.—Arizona roundtail ground squirrel (20 miles southwest of Phoenix); valley pocket gopher (in range).

Kangaroo rats and pocket mice.—Arizona pocket mouse (20 miles southwest of Phoenix); Merriam's kangaroo rat (20 miles southwest of Phoenix); desert kangaroo rat (in range).

Rats and mice.—Cactus mouse (20 miles southwest of Phoenix).

Dogs.—Coyote (in range); kit fox (in range).

Raccoons and allies.—Ringtail (in range); raccoon (Gila River Bosque).

Weasels and allies.—Striped skunk (20 miles southwest of Phoenix).

Cats.—Bobcats (in range).

Javelina.—Peccary (in range).

Deer and allies.—Desert mule deer (in range).

Bighorn sheep.—Desert sheep (Estrella Mountains).

Reptiles and Amphibians

Geckos.—Desert gecko (rocky hills).

Lizards.—Desert iguana (creosotebush flats); tree lizard (desert riparian areas);

desert side-botched lizard (sandy rocky washes); desert horned lizard (creosotebush, cactus; arid plains); Gila monster (throughout area).

Snakes.—Desert patchnosed snake (dry creosotebush plains; along streambeds);

Pima leathernosed snake (upland desert); western long-nose snake (upland desert); western groundsnake (damp riparian areas); banded sandsnake (creosotebush, paloverde);

Sonora sidewinder (desert sand areas).

Toads and frogs.—Western spadefoot toad (washes, flood plains and playas);

Colorado River toad (mesquite, creosotebush; areas along washes).

Tortoises.—Desert tortoise (throughout area near hills and mountains).

Birds

Doves.—Mourning dove (throughout survey area); whitewing dove (throughout survey area).

Cuckoos.—Roadrunner (throughout survey area).

Owls.—Elf owl (throughout survey area); burrowing owl (throughout survey area).

Hummingbirds.—Costas (throughout survey area).

Woodpecker.—Gila (mountain foothills area).

Wrens.—Cactus (common in mesquite and cholla).

Thrashers.—Curvebill (open creosotebush desert); Le Contes (open creosotebush desert).

Flycatchers.—Phainopepla (paloverde and mesquite trees).

Quail.—Gambels (in area).

Vultures, hawks, and falcons.—Turkey vulture (in area); black vulture (in area);

Harris's hawk (in area); red-tailed hawk (in area).

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

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

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given 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 the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(3)* and the system adopted by the American Association of State Highway and Transportation Officials *(2)*.

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 and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups 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 (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It 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 nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; *high*, more than 6 percent; and *very high*, greater than 9 percent.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation

(USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.64. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are as follows:

1. Coarse sands, sands, fine sands, and very fine sands.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and sapric soil material.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In Table 14, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive 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 mainly of deep, well drained to excessively drained sands or gravelly sands. 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 having a layer that impedes the downward movement of water or soils of 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 clays that have a high shrink-swell potential, soils that have a 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.

If a soil is assigned to two hydrologic groups in Table 15, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in

Figure 13.—Corrosion by sulfates in the soil has caused the deterioration of this concrete-lined ditch.

any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of flooding is more than 50 percent in any year). *Common* is used when the occasional and frequent classes are grouped for certain purposes. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

A *cemented pan* is a cemented or indurated subsurface layer within a depth of 5 feet. Such a pan causes difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 15 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract (fig. 13)

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(49)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 16 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Fluvent (*Fluv*, meaning flood plain sediment, 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 development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Torrifluvents (*Torri*, meaning hot and dry, plus *fluvent*, the suborder of the Entisols that formed in flood plain sediment).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Torrifluvents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle size, mineral content, soil temperature regime, soil depth, and reaction. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-silty, mixed, (calcareous), hyperthermic Typic Torrifluvents.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(47)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(49)*. Unless otherwise indicated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Brios Series

Depth class: very deep
Drainage class: excessively drained
Landform: alluvial fans and flood plains
Parent material: sandy fan alluvium and stream alluvium derived dominantly from granite and schist
Slope range: 0 to 5 percent
Elevation: 950 to 1,550 feet
Classification: sandy, mixed, hyperthermic Typic Torrifluvents.

Typical Pedon

Brios gravelly loamy sand, 3 to 5 percent slopes, about 500 feet south and 200 feet east of the NE corner of sec. 5, T.4 S., R.2 E:

C1—0 to 2 inches; light yellowish brown (10YR 6/4) gravelly loamy sand, dark yellowish brown (10YR 3/4) moist; moderate very thin and thin platy structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; common very fine irregular pores; 15 percent fine gravel and 1 percent cobble; rock fragments partially coated with lime; noneffervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

C2—2 to 26 inches; light yellowish brown (10YR 6/4) loamy coarse sand, dark yellowish brown (10YR 4/4) moist; single grain; loose; many very fine and few fine and medium roots; 10 percent fine gravel and 1 percent cobble; rock fragments partially coated with lime; noneffervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Ck1—26 to 38 inches; light yellowish brown (10YR 6/4) loamy coarse sand, dark yellowish brown (10YR 4/4) moist; single grain; loose; common very fine and few fine roots; 10 percent fine gravel and 1 percent cobble; rock fragments partially coated with lime; violently effervescent; moderately alkaline (pH 8.4); gradual wavy boundary.

Ck2—38 to 60 inches; very pale brown (10YR 7/4) coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; few very fine roots; 5 percent fine gravel and 1 percent cobble; rock fragments partially coated with lime; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Average content of rock fragments in the control section: less than 15 percent

C horizons:

Texture—coarse sandy loam, very fine sandy loam or gravelly loamy sand

Effervescence—noneffervescent to violently effervescent

Sodicity (SAR)—1 to 13

Reaction—mildly alkaline to strongly alkaline

Ck horizons:

Texture—gravelly coarse sand, loamy coarse sand and coarse sand

Color—yellowish brown, light yellowish brown or very pale brown

Carrizo Series

Depth class: very deep

Drainage class: excessively drained

Landform: fan terraces and flood plains

Parent material: sandy stream alluvium and fan alluvium derived dominantly from granite and schist

Slope range: 0 to 5 percent

Elevation: 940 to 1,800 feet

Classification: sandy-skeletal, mixed, hyperthermic Typic Torriorthents

Typical Pedon

Carrizo very gravelly coarse sand, 0 to 1 percent slopes about 2,600 feet south and 300 feet west of the NE corner of sec. 6, T.4 S., R.2 E.

C1—0 to 6 inches; light yellowish brown (10YR 6/4) very gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; few very fine and fine roots; common very fine irregular pores; 50 percent lime-coated fine, medium, and coarse gravel; strongly effervescent; mildly alkaline (pH 7.8); abrupt smooth boundary.

C2—6 to 42 inches; light yellowish brown (10YR 6/4) very gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; few fine and medium roots; common very fine irregular pores; 40 percent lime-coated fine gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C3—42 to 52 inches; light yellowish brown (10YR 6/4), very gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; few fine roots; few very fine irregular pores; 55 percent lime-coated medium and coarse gravel; strongly effervescent; mildly alkaline (pH 7.8) abrupt smooth boundary.

2Cb—52 to 60 inches; strong brown (7.5YR 5/6), very gravelly loamy coarse sand, strong brown (7.5YR 4/6) moist; single grain loose; common fine irregular pores; 40 percent lime-coated fine and medium gravel; noneffervescent; mildly alkaline (pH 7.8).

Range in Characteristics

Depth to a buried horizon: 40 to 60 inches or more

C horizon:

Texture—stratified gravelly coarse sand and very gravelly coarse sand, gravelly sandy loam

Color—pale brown, light yellowish brown or very pale brown

Reaction—mildly alkaline or moderately alkaline

2C horizon:
Texture—gravelly sandy loam, gravelly loamy fine sand or very gravelly loamy coarse sand
Color—light yellowish brown, strong brown, pale brown or yellowish brown

Casa Grande Series

Depth class: very deep
Drainage class: well drained
Landform: relict basin floors
Parent material: loamy basin alluvium
Slope range: 0 to 5 percent
Elevation: 950 to 1,200 feet
Classification: fine-loamy, mixed, hyperthermic Typic Natrargids

Typical Pedon

Casa Grande fine sandy loam, 0 to 3 percent slopes about 2,450 feet south and 2,500 feet east of the NW corner of sec. 29, T.2 S., R.4 E.

An—0 to 1 inch; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; few very fine irregular pores; strongly effervescent; strongly alkaline (pH 8.6); very slightly saline (ECe 2 dS/m) and slightly sodic (SAR 5); clear smooth boundary.

BAn—1 to 5 inches; pale brown (10YR 6/3) fine sandy loam , dark brown (10YR 4/3) moist; strong medium and coarse angular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; few very fine irregular pores; violently effervescent; strongly alkaline (pH 8.6); very slightly saline (ECe 2 dS/m) and moderately sodic (SAR 28); gradual wavy boundary.

Btknz1—5 to 8 inches; light yellowish brown (10YR 6/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure; hard, very friable, sticky and plastic; few very fine roots; common very fine tubular and irregular pores; common distinct clay skins on ped faces and lining pores; few fine and medium, rounded, soft accumulations of lime and salt (6 percent $CaCO_3$); violently effervescent; very strongly alkaline (pH 9.6); slightly saline (ECe 6 dS/m) and strongly sodic (SAR 65); clear smooth boundary.

Btknz2—8 to 11 inches; light yellowish brown (10YR 6/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure; hard, very friable; sticky and plastic; few very fine roots; common very fine tubular and irregular pores; common distinct clay skins on ped faces and lining pores; few fine and medium, rounded, soft accumulations of lime and salt (10 percent $CaCO_3$); violently effervescent; very strongly alkaline (pH 9.6); moderately saline (ECe 8 dS/m) and strongly sodic (SAR 107); gradual wavy boundary.

Btknz3—11 to 18 inches; strong brown (7.5YR 5/6) clay loam, strong brown (7.5YR 4/6) moist; strong medium prismatic structure parting to strong medium and coarse angular blocky; hard, very friable, sticky and plastic; few very fine and fine roots; common very fine and fine and few fine tubular and irregular pores; many prominent clay skins on ped faces and lining pores; many medium and coarse, vertically oriented, cylindrical, soft accumulations of lime (14 percent $CaCO_3$); violently effervescent; strongly alkaline (pH 8.8); strongly saline (ECe 16 dS/m) and strongly sodic (SAR 185); gradual wavy boundary.

Btknz4—18 to 32 inches; strong brown (7.5YR 5/6) clay loam, strong brown (7.5YR 4/6) moist; strong medium prismatic structure parting to strong medium and coarse angular blocky; hard, very friable, sticky and plastic; few very fine and fine roots; common very fine and few fine tubular and irregular pores; many prominent clay skins on ped faces and lining pores; few dark brown manganese coatings on ped faces; many medium and coarse, vertically oriented, cylindrical, soft accumulations of lime (19 percent $CaCO_3$); violently effervescent; strongly alkaline (pH 8.8); strongly saline (ECe 27 dS/m) and strongly sodic (SAR 147); clear wavy boundary.

Btknz5—32 to 39 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4), moist; moderate medium and coarse angular blocky structure; very hard, very friable, sticky and plastic; few very fine irregular pores; few fine clay skins bridging mineral grains; few dark brown manganese coatings on ped faces; few fine and medium, rounded, soft accumulations of lime (15 percent $CaCO_3$); violently effervescent; strongly alkaline (pH 8.8); strongly saline (ECe 26 dS/m) and strongly sodic (SAR 137); abrupt smooth boundary.

2BCknz1—39 to 46 inches; light yellowish brown (10YR 6/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine irregular pores; 14 percent fine and medium gravel; few dark brown manganese coatings on ped faces; many soft lime coatings on gravel (8 percent $CaCO_3$); violently effervescent; strongly alkaline (pH 8.8); strongly saline (ECe 25 dS/m) and strongly sodic (SAR 77); clear smooth boundary.

2BCknz2—46 to 60 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine irregular pores; many coarse and very coarse, soft, rounded accumulations of lime (17 percent $CaCO_3$); dominantly violently effervescent with spots that are noneffervescent; moderately alkaline (pH 8.4); strongly saline (ECe 29 dS/m) and strongly sodic (SAR 29).

Range in Characteristics

A horizon:
Texture—fine sandy loam, clay loam, or silt loam
Color—light brown, pale brown or very pale brown
Effervescence—strongly or violently effervescent
Salinity (ECe)—2 to 28 dS/m
Sodicity (SAR)—5 to 160
Reaction—moderately to very strongly alkaline

Bt horizon:
Texture—loam, sandy clay loam or clay loam
Color—brown, light brown, light reddish brown, reddish yellow or yellowish red
Effervescence—strongly or violently effervescent
Salinity (ECe)—9 to 45 dS/m
Sodicity (SAR)—100 to 1,140
Reaction—strongly to very strongly alkaline

BC horizon:
Texture—sandy loam, loam, sandy clay loam, clay loam, silt loam or silty clay loam
Color—brown, light brown, light reddish brown, reddish yellow or very pale brown
Effervescence—strongly or violently effervescent
Salinity (ECe)—8 to 41 dS/m
Sodicity (SAR)—120 to 920
Reaction—moderately to very strongly alkaline

Some pedons do not have BA horizons. Drainage mottles, nodules or gypsum crystals are below the control section in some pedons.

Cavelt Series

Depth class: shallow (to a hard pan)
Drainage class: somewhat excessively drained
Landform: high fan terraces
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 1 to 10 percent
Elevation: 950 to 1,500 feet
Classification: loamy, mixed, hyperthermic, shallow Typic Paleorthids

Typical Pedon

Cavelt very gravelly loam in an area of Cavelt-Carrizo-Gunsight complex, 1 to 10 percent slopes about 700 feet east and 200 feet north of the SW corner of sec. 6, T.1 S., R.1 E.

A—0 to 1 inch; light brown (7.5YR 6/4) very gravelly loam, strong brown (7.5YR 5/6) moist; moderate fine subangular blocky structure soft, very friable, nonsticky and slightly plastic; many very fine roots; many very fine vesicular pores; 50 percent fine and medium gravel; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw—1 to 8 inches; pink (7.5YR 7/4) gravelly loam, strong brown (7.5YR 5/6) moist; moderate fine and medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many very fine and few fine roots; many very fine tubular pores; 20 percent lime-coated fine and medium gravel; strongly effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

2Bkm1—8 to 17 inches; white (10YR 8/1) strongly lime cemented sandy loam, white (10YR 8/2) moist; massive; hard, friable, nonsticky and nonplastic; common very fine roots; 10 percent lime-coated fine gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

2Bkm2—17 to 24 inches; white (10YR 8/1) indurated, lime-cemented hardpan, white (10YR 8/2) moist, extremely hard, extremely firm, violently effervescent.

Range in Characteristics

Depth to the petrocalcic horizon: 3 to 20 inches

Chuckawalla Series

Depth class: very deep
Drainage class: well drained
Landform: high fan terraces
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 1 to 5 percent
Elevation: 1,100 to 1,500 feet
Classification: loamy-skeletal, mixed, hyperthermic Typic Haplargids

Typical Pedon

Chuckawalla extremely gravelly loam in an area of Chuckawalla-Gunsight complex, 1 to 5 percent slopes about 1,100 feet south and 2,000 feet west of the NE corner of sec. 8, T.4 S., R.2 E.

A—0 to 2 inches; pink (7.5YR 7/4) extremely gravelly loam, strong brown (7.5YR 5/6) moist; strong thick and very thick platy structure; slightly hard, very friable, slightly sticky and plastic; few very fine roots; many very fine vesicular pores; very few distinct clay coatings on sand grains; 55 percent fine, medium, and coarse gravel; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Btkz—2 to 10 inches; reddish yellow (5YR 6/6) very gravelly loam, yellowish red (5YR 5/6) moist; strong medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine tubular pores; very few distinct clay skins bridging and coating sand grains; 40 percent lime-coated fine, medium, and coarse gravel; slightly effervescent; moderately alkaline (pH 8.4); moderately saline; clear wavy boundary.

Bkz—10 to 57 inches; pinkish white (7.5YR 8/2) extremely gravelly sandy loam, light brown (7.5YR 6/4) moist; massive; weakly cemented; very hard, firm, nonsticky and slightly plastic; common very fine roots; no pores observed; 85 percent lime-coated fine, medium, and coarse gravel; strongly effervescent; moderately alkaline (pH 8.0); strongly saline; abrupt wavy boundary.

2Ck—57 to 60 inches; white (10YR 8/1) very gravelly sand, light gray (10YR 7/2) moist; massive; weakly cemented; very hard, firm; no roots or pores observed; 55 percent lime-coated fine, medium, and coarse gravel; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Depth to the calcic horizon: 6 to 20 inches

A horizon:
Color—pale brown, light brown or pink
Effervescence—slightly to violently effervescent
Salinity (ECe)—1 to 4 dS/m

Bt horizon:
Color—light reddish brown, reddish yellow or yellowish red
Effervescence—slightly to violently effervescent
Salinity (ECe)—5 to 20 dS/m
Reaction—moderately or strongly alkaline

Bk horizon:
Texture—very gravelly sandy loam, very gravelly loam or extremely gravelly sandy loam
Color—white or pinkish white

About 85 to 95 percent of the surface is covered by a desert pavement of gravel that has a thin layer of desert varnish.

Cristobal Series

Depth class: deep (to a hardpan)
Drainage class: well drained
Landform: high fan terraces
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 3 to 15 percent
Elevation: 1,100 to 1,800 feet
Classification: loamy-skeletal, mixed, hyperthermic Typic Haplargids

Typical Pedon

Cristobal very gravelly loam in an area of Cristobal-Gunsight complex, 3 to 15 percent slopes about 400 feet north and 30 feet east of the SW corner of sec. 7, T.3 S., R.7 E.

A—0 to 1 inch; reddish yellow (7.5YR 6/6) very gravelly loam, brown (7.5YR 4/4) moist; moderate thin platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine vesicular pores; 40 percent gravel; noneffervescent; mildly alkaline (pH 7.8); abrupt smooth boundary.

Bt—1 to 4 inches; reddish yellow (5YR 6/6) very gravelly sandy clay loam, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, very friable, sticky and slightly plastic; many very fine roots; many very fine tubular pores; common distinct clay coatings on mineral grains; 50 percent gravel; noneffervescent; mildly alkaline (pH 7.6); gradual wavy boundary.

Btk1—4 to 10 inches; yellowish red (5YR 5/6) extremely gravelly sandy clay loam, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, very friable, sticky and plastic; many very fine roots; common very fine tubular pores; common prominent clay skins bridging mineral grains; 70 percent lime-coated gravel and cobble; few fine and medium soft lime masses; strongly effervescent; mildly alkaline (pH 7.4); gradual wavy boundary.

Btk2—10 to 41 inches; red (2.5YR 5/6) extremely gravelly sandy clay loam, red (2.5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, very friable, sticky and plastic; many very fine roots; many very fine tubular pores; many prominent clay skins bridging mineral grains; 70 percent lime-coated gravel and cobble;

noneffervescent in fine earth fraction; moderately alkaline (pH 8.2).

2Ckqm—41 to 60 inches; pinkish white (7.5YR 8/2) silica-lime cemented hardpan; extremely hard; violently effervescent.

Range in Characteristics

Average content of rock fragments in the control section: Rock fragments range from 15 to 70 percent gravel and cobbles throughout and average more than 35 percent in the control section.

A horizon:
Color— very pale brown, reddish yellow or light yellowish brown
Reaction—mildly or moderately alkaline

Bt horizon:
Texture—extremely gravelly sandy clay loam, gravelly sandy loam or very gravelly loam
Color—red, reddish yellow, yellowish red or reddish brown
Effervescence—noneffervescent to slightly effervescent
Reaction—mildly or moderately alkaline
Some pedons do not have an indurated hardpan at a depth of 40 inches or more.

Cuerda Series

Depth class: very deep
Drainage class: well drained
Landform: flood plains
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 0 to 3 percent
Elevation: 900 to 1,200 feet
Classification: coarse-loamy, mixed, hyperthermic Fluventic Camborthids

Typical Pedon

Cuerda very fine sandy loam in an area of Dateland-Cuerda complex, saline-sodic, 0 to 3 percent slopes about 2,000 feet west and 100 feet north of the southeast corner of sec. 9, T.2 S., R.3 E.

A1—0 to 3 inches; light brown (7.5YR 6/4) stratified very fine sandy loam, brown (7.5YR 4/4) moist; strong medium platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—3 to 6 inches; light brown (7.5YR 6.4) stratified fine sandy loam, brown (7.5YR 4/4) moist; moderate medium platy structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; violently effervescent; strongly alkaline (pH 8.5) abrupt wavy boundary.

2Bw—6 to 21 inches; reddish yellow (7.5YR 6/6) loam, strong brown (7.5YR 5/6) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; few distinct clay bridges between mineral grains; (6 percent $CaCO_3$), common very fine vertically oriented calcium carbonate masses and threads; nonsaline (ECe 1 dS/m), slightly sodic (SAR 9); 1 percent gravel; strongly alkaline (pH 8.5); clear smooth boundary.

2Bknz1—21 to 31 inches; reddish yellow (7.5YR 6/6) loam, brown (7.5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; violently effervescent (3 percent $CaCO_3$), few very fine vertically oriented calcium carbonate threads, moderately saline (ECe 13 dS/m), few fine salt threads; moderately sodic (SAR 17); moderately alkaline (pH 8.2); clear smooth boundary.

2Bknz2—31 to 60 inches; reddish yellow (7.5YR 6/6) loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; (3 percent $CaCO_3$), common very fine vertically oriented calcium carbonate threads; strongly saline (ECe 19 dS/m), common very fine salt threads; strongly sodic (SAR 32); moderately alkaline (pH 8.0).

Range in Characteristics

Depth to a buried argillic horizon: more than 40 inches in some pedons
Average content of rock fragments in the control section: less than 5 percent

A horizon:
Color—pale brown, light brown or brown
Salinity (ECe)—less than 8 dS/m
Reaction—mildly to moderately alkaline

2B horizon:
Texture—loam or very fine sandy loam
Color—reddish yellow, strong brown or brown
Salinity (ECe)—1 to 19 dS/m
Sodicity (SAR)—8 to 32
Buried Bt horizons are common below 40 inches.

Dateland Series

Depth class: very deep
Drainage class: well drained
Landform: low fan terraces
Parent material: loamy fan alluvium
Slope range: 0 to 3 percent
Elevation: 900 to 1,200 feet
Classification: coarse-loamy, mixed, hyperthermic Typic Camborthids

Typical Pedon

Dateland fine sandy loam in an area of Dateland-Cuerda complex, saline-sodic, 0 to 3 percent slopes about 2,600 feet west and 300 feet north of the southeast corner of sec. 8, T.2 S., R.3 E.

A—0 to 10 inches; very pale brown (10YR 7/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, very friable; many very fine roots; many fine vesicular pores; slightly effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bnz1—10 to 22 inches; reddish yellow (7.5YR 6/6) loam, brown (7.5YR 4/4) moist; massive; slightly hard, very friable, slightly plastic; many very fine roots; many very fine tubular pores; strongly effervescent; moderately saline (ECe 12 dS/m); very strongly alkaline (pH 9.6); clear wavy boundary.

Bnz2—22 to 52 inches; strong brown (7.5YR 5/6) loam, brown (7.5YR 4/4) moist; massive; slightly hard, very friable, slightly plastic; many very fine roots; many very fine tubular pores; strongly effervescent; moderately saline (ECe 14 dS/m); very strongly alkaline (pH 9.2); clear wavy boundary.

Bnz3—52 to 60 inches; strong brown (7.5YR 5/6) loam, brown (7.5YR 4/4) moist; massive; hard, very friable, sticky and plastic; many very fine roots; common very fine tubular pores; strongly effervescent; common very fine salt crystals, strong saline (ECe 25 dS/m); strongly alkaline (pH 8.8).

Range in Characteristics

Depth to a buried argillic horizon: more than 40 inches in some pedons

A horizon:
Color—very pale brown, brown or dark yellowish brown
Salinity (ECe)—less than 8 dS/m

B horizon:
Texture—very fine sandy loam or loam
Color—reddish yellow, strong brown or brown
Salinity (ECe)—8 to 25 dS/m

Small carbonate masses also occur below 30 inches in some pedons.

Denure Series

Depth class: very deep
Drainage class: somewhat excessively drained
Landform: fan terraces
Parent material: loamy fan alluvium
Slope range: 1 to 5 percent
Elevation: 1,000 to 1,450 feet
Classification: coarse-loamy, mixed, hyperthermic Typic Camborthids

Typical Pedon

Denure gravelly coarse sandy loam in an area of Denure-Pahaka complex, 1 to 3 percent slopes about 2,600 feet south and 30 feet east of the NW corner of sec. 3, T.4 S., R.2 E.

A1—0 to 1 inch; light yellowish brown (10YR 6/4) gravelly coarse sandy loam, dark yellowish brown (10YR 4/4) moist; weak medium platy structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; common very fine irregular pores; 15 percent fine gravel; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

A2—1 to 3 inches; light brown (7.5YR 6/4) gravelly coarse sandy loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; common very fine irregular pores; 15 percent fine gravel; noneffervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

Bw—3 to 18 inches; reddish yellow (7.5YR 6/6) gravelly coarse sandy loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine irregular pores; 23 percent fine gravel; violently effervescent; moderately alkaline (pH 8.2); gradual wavy boundary.

Bk1—18 to 30 inches; reddish yellow (7.5YR 6/6) gravelly coarse sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots;

common very fine irregular pores; 25 percent gravel; lime coatings on bottom of gravel; violently effervescent; moderately alkaline (pH 8.4); gradual wavy boundary.

Bk2—30 to 49 inches; reddish yellow (7.5YR 6/6) gravelly coarse sandy loam, strong brown (7.5YR 5/6) moist; moderate medium subangular blocky structure; hard, very friable, nonsticky and nonplastic; moderate very fine roots; moderate very fine irregular pores; 30 percent gravel; few fine, irregular, soft accumulations of lime; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2Btkb—49 to 60 inches; reddish yellow (7.5YR 6/6) very gravelly coarse sandy loam, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; very hard, friable, slightly sticky and nonplastic; few very fine roots; few very fine irregular pores; irregular lime coatings on gravel; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Average content of rock fragments in the control section: less than 35 percent (ranges from 5 to 20 percent)

A horizon:
- Texture—very gravelly fine sandy loam or gravelly coarse sandy loam
- Color—light brown, pale brown, light yellowish brown, yellowish brown, brownish yellow or reddish yellow
- Effervescence—noneffervescent to violently effervescent
- Reaction—mildly to moderately alkaline

B horizon:
- Texture—coarse sandy loam or gravelly coarse sandy loam
- Color—brown, strong brown, light brown and reddish yellow
- Effervescence—strongly or violently effervescent
- Reaction—moderately alkaline

Gadsden Series

Depth class very deep
Drainage class: well drained
Landform: flood plains
Parent material: clayey stream alluvium
Slope range: 0 to 2 percent
Elevation: 940 to 1,400 feet
Classification: fine, montmorillonitic (calcareous), hyperthermic Vertic Torrifluvents

Typical Pedon

Gadsden silty clay loam, saline-sodic, 0 to 2 percent slopes, about 200 feet north and 1,300 feet west of the SE corner of sec. 24, T.3 S., R.5 E.

A—0 to 2 inches; pale brown (10YR 6/3) silty clay loam, dark yellowish brown (10YR 3/4) moist; moderate fine platy structure; slightly hard, very friable, sticky and plastic; common very fine roots between plates; many very fine vesicular pores; violently effervescent; slightly sodic (SAR less than 10); moderately alkaline (pH 8.4); abrupt smooth boundary.

C—2 to 10 inches; pale brown (10YR 6/3) silty clay, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, very friable, sticky and plastic; common very fine roots; common very fine tubular pores; violently effervescent; nonsaline (1.1 dS/m); slightly sodic (SAR less than 10); mildly alkaline (pH 8.2); clear smooth boundary.

Cz1—10 to 23 inches; light yellowish brown (10YR 6/4) silty clay, dark yellowish brown (10YR 3/4) moist; strong medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; violently effervescent; common fine cylindrical soft salt masses; moderately saline (ECe 12 dS/m); slightly sodic (SAR 8); mildly alkaline (pH 8.0); clear smooth boundary.

Cz2—23 to 36 inches; brown (10YR 5/3) silty clay, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; very hard, friable, sticky and plastic; few very fine roots; many very fine tubular pores; violently effervescent; common fine cylindrical soft salt masses; strongly saline (ECe 18 dS/m); slightly sodic (SAR 12); mildly alkaline (pH 8.0); clear smooth boundary.

Cnz—36 to 60 inches; light yellowish brown (10YR 6/4) silty clay, dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common very fine tubular pores; violently effervescent; few fine cylindrical soft salt masses, moderately saline (ECe 14 dS/m); moderately sodic (SAR 15; mildly alkaline (pH 8.0).

Range in Characteristics

A horizon:
- Color—light brown, light yellowish brown, pale brown, brown or dark brown
- Effervescence—slightly to violently effervescent
- Salinity (ECe)— less than 1 to 16 dS/m
- Sodicity (SAR)—4 to 10

Reaction—moderately or strongly alkaline

C horizons:

Texture—stratified silty clay and silty clay loam. Contain thin strata of finer or coarser material.

Color—brown, pale brown, light yellowish brown or dark brown

Effervescence—strong to violently effervescent

Salinity (ECe)—1 to 34 dS/m

Sodicity (SAR)—4 to 27

Reaction—moderately to strongly alkaline

Most pedons have accumulations of salt throughout the profile.

Glenbar Series

Depth class: very deep
Drainage class: well drained
Landform: flood plains
Parent material: silty stream alluvium
Slope range: 0 to 2 percent
Elevation: 940 to 1,400 feet
Classification: fine-silty, mixed (calcareous), hyperthermic Typic Torrifluvents

Typical Pedon

Glenbar silt loam, saline-sodic, 0 to 2 percent slopes about 1,300 feet west and 100 feet north of the SE corner of sec. 23, T.2 S., R.2 E.

Anz—0 to 4 inches; brown (10YR 5/3) stratified silt loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, slightly sticky and plastic; many very fine roots; few very fine irregular pores; strongly effervescent; moderately saline (ECe 12 dS/m); strongly alkaline (pH 8.6); abrupt wavy boundary.

Cnz1—4 to 9 inches; brown (10YR 5/3) stratified silt loam, dark brown (10YR 4/3) moist; moderately thin platy structure; slightly hard, very friable, plastic; many very fine roots; few very fine tubular pores; violently effervescent; strongly saline (ECe 36 dS/m) strongly alkaline (pH 8.8); abrupt wavy boundary.

Cnz2—9 to 23 inches; pale brown (10YR 6/3) stratified silt loam, dark brown (10YR 4/3) moist; massive, slightly hard, very friable, sticky and plastic; few fine roots, few very fine tubular pores; violently effervescent; strongly saline (ECe 32 dS/m); strongly alkaline (pH 9.0); abrupt smooth boundary.

Cnz3—23 to 60 inches; grayish brown (10YR 5/2) stratified silty clay loam, very dark grayish brown (10YR 3/2) moist; massive; hard, firm, very sticky and very plastic; few fine roots, many fine tubular pores; violently effervescent; strongly saline (ECe 50 dS/m); strongly alkaline (pH 8.8).

Range in Characteristics

A horizon:

Color—light brown, brown or dark brown

Effervescence—slightly to violently effervescent

Salinity (ECe)—1 to 16 dS/m

Reaction—moderately or strongly alkaline

C horizon:

Texture—stratified silt loam and silty clay loam with strata of finer and coarser material

Color—brown, pale brown, dark brown or grayish brown

Effervescence—strongly to violently effervescent

Salinity (ECe)—8 to 50 dS/m

Reaction—moderately to strongly alkaline

Most pedons have accumulations of salt throughout the profile.

Gunsight Series

Depth class: very deep
Drainage class: somewhat excessively drained
Landform: high fan terraces
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 1 to 15 percent
Elevation: 950 to 1,800 feet
Classification: loamy-skeletal, mixed, hyperthermic Typic Calciorthids

Typical Pedon

Gunsight very gravelly loam in an area of Chuckawalla-Gunsight complex, 1 to 5 percent slopes about 1,100 feet south and 1,180 feet west of the NE corner of sec. 8, T.4 S., R.2 E.

A—0 to 1 inch; reddish yellow (7.5YR 7/6) very gravelly loam, strong brown (7.5YR 5/6) moist; strong thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine vesicular pores; 45 percent fine, medium, and coarse gravel; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—1 to 3 inches; light brown (7.5YR 6/4) gravelly sandy loam, brown (7/5YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, common fine and medium roots; many very fine tubular pores; 25 percent fine and medium gravel; noneffervescent;

moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk—3 to 46 inches; very pale brown (10YR 7/3) very gravelly sandy loam, pale brown (10YR 6/3) moist; massive; weakly cemented; slightly hard, very friable, slightly sticky and nonplastic; common fine and medium roots; many very fine and fine tubular pores; 55 percent lime-coated fine, medium, and coarse gravel, few cobbles; many fine lime masses; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

2Ck—46 to 60 inches; pale brown (10YR 6/3) very gravelly sand, brown (10YR 5/3) moist; massive; loose; no roots observed; many very fine irregular pores; 40 percent lime-coated fine and medium gravel; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to the calcic horizon: 3 to 20 inches

A horizon:
Texture—very gravelly loam or very gravelly sandy loam
Color—reddish yellow, light yellowish brown or very pale brown
Effervescence—noneffervescent to violently effervescent

Bk horizon:
Texture—very gravelly sandy loam or extremely gravelly sandy loam
Color—very pale brown or light yellowish brown
Cementation—weakly to strongly cemented in some pedons
Some pedons have a buried argillic horizon at depths greater than 40 inches.

Indio Series

Depth class: very deep
Drainage class: well drained
Landform: flood plains
Parent material: silty stream alluvium
Slope range: 0 to 3 percent
Elevation: 940 to 1,400 feet
Classification: coarse-silty, mixed (calcareous), hyperthermic Typic Torrifluvents

Typical Pedon

Indio silt loam in an area of Indio-Vint complex, saline-sodic, 0 to 3 percent slopes about 2,400 feet south and 1,100 feet east of the NW corner of sec. 24, T.3 S., R.3 E. (fig. 14).

Anz—0 to 3 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; strong thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many fine vesicular pores; violently effervescent; strongly alkaline (pH 8.8); moderately saline (ECe 8 dS/m) and strongly sodic (SAR 32); gradual wavy boundary.

Cnz—3 to 10 inches; light yellowish brown (10YR 6/4) silt loam, brown (10YR 4/3) moist; moderate coarse subangular blocky structure; slightly hard, very friable, sticky and plastic; common very fine and few fine roots; many very fine irregular pores; violently effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 17 dS/m) and strongly sodic (SAR 170); clear smooth boundary.

Cnz1—10 to 24 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; violently effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 32 dS/m) and strongly sodic (SAR 304); clear smooth boundary.

Cnz2—24 to 44 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common fine irregular pores; violently effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 33 dS/m) and strongly sodic (SAR 259); abrupt smooth boundary.

Cnz3—44 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; soft, very friable, sticky and plastic; common very fine and fine, tubular and irregular pores; violently effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 22 dS/m) and strongly sodic (SAR 270).

Range in Characteristics

A horizon:
Color—pale brown, very pale brown or light yellowish brown
Effervescence—strongly or violently effervescent
Salinity (ECe)—2 to 18 dS/m
Sodicity (SAR)—5 to 32
Reaction—moderately to very strongly alkaline

C horizon:
Texture—stratified silt loam, very fine sandy loam and silty clay loam. Some pedons contain strata of finer or coarser material.
Color—light brown, pale brown, very pale brown, light yellowish brown or yellowish brown
Effervescence—strongly or violently effervescent

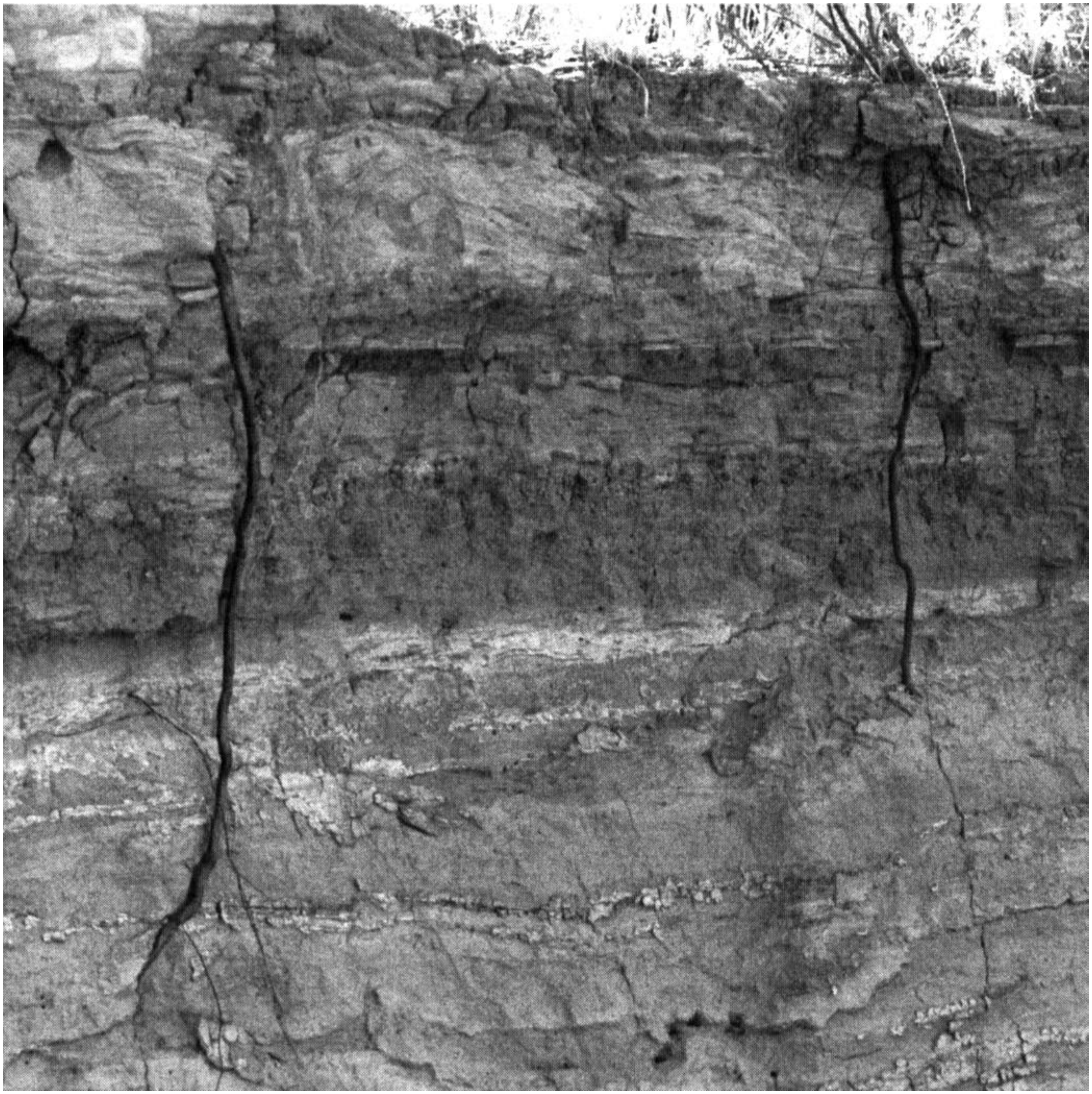


Figure 14.—Soil profile of a Typic Torrifluvent (Indio silt loam, saline-sodic, 0 to 2 percent slopes), showing stratification common to these soils.

Salinity (ECe)—17 to 51 dS/m
Sodicity (SAR)—121 to 523 (1,180 in some pedons)
Reaction—strongly or very strongly alkaline. Some pedons have drainage mottles throughout. Thick layers of fine sand, silty clay loam or silty clay are at depths greater than 40 inches in some pedons.

Kamato Series

Depth class: very deep
Drainage class: well drained
Lanform: relict basin floors
Parent material: clayey basin alluvium
Slope range: 0 to 5 percent
Elevation: 950 to 1,150 feet

Classification: fine, mixed, hyperthermic Typic Natrargids

Typical Pedon

Kamato fine sandy loam in an area of Kamato complex, 0 to 5 percent slopes about 1,300 feet north and 600 feet west of the SE corner of sec. 6, T.3 S., R.5 E.

An—0 to 6 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; strong coarse angular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine vesicular and irregular pores; violently effervescent; very strongly alkaline (pH 9.2); very slightly saline (ECe 2.0 dS/m) and slightly sodic (SAR 9); clear smooth boundary.

BAnz—6 to 11 inches; strong brown (7.5YR 5/6) loam, strong brown (7.5YR 4/6) moist; strong medium prismatic structure; hard, very friable, sticky and plastic; common very fine roots; many very fine and fine, tubular and irregular pores; violently effervescent; very strongly alkaline (pH 9.4); moderately saline (ECe 13 dS/m); and strongly sodic (SAR 101); gradual wavy boundary.

Btknz1—11 to 26 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR4/4) moist; strong medium and coarse prismatic structure; extremely hard, firm, very sticky and very plastic; few very fine roots; common very fine and fine tubular pores; many prominent clay skins on ped faces and lining pores; many medium and coarse, vertically oriented, cylindrical, soft accumulations of lime; violently effervescent; very strongly alkaline (pH 9.0); strongly saline (ECe 43 dSm) and strongly sodic (SAR 108) gradual wavy boundary.

Btknz2—26 to 34 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; strong medium and coarse prismatic structure; extremely hard, firm, very sticky and very plastic; common very fine and fine tubular pores; many prominent clay skins on ped faces and lining pores; few medium and coarse, vertically oriented, cylindrical, soft accumulations of lime; violently effervescent; strongly alkaline (pH 8.8); strongly saline (ECe 42 dS/m) and strongly sodic (SAR 100); clear smooth boundary.

Btknzy—34 to 60 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; strong medium angular blocky structure; hard, very friable, very sticky and very plastic; common very fine tubular pores; many prominent clay skins on ped faces and lining pores; many fine and medium, irregular, soft accumulations of lime; 6 percent fine and medium, rounded, gypsum crystals; violently effervescent; strongly alkaline (pH 8.8); strongly saline (ECe 25 dS/m) and strongly sodic (SAR 90).

Range in Characteristics

A horizon:
Texture—fine sandy loam, loam or clay loam
Color—light yellowish brown, light reddish brown, reddish brown, or light gray
Effervescence—strongly or violently effervescent
Salinity (ECe)—less than 2 to 5 dS/m
Sodicity (SAR)—4 to 10
Reaction—moderately to very strongly alkaline

Bt horizon:
Texture—sandy clay loam, clay loam or clay
Color—brown, reddish brown or light reddish brown
Effervescence—strongly or violently effervescent
Salinity (ECe)—5 to 43 dS/m
Sodicity (SAR)—66 to 108
Reaction—strongly or very strongly alkaline
Some pedons do not have BA horizon or gypsum crystals. A Bk or C horizon is below the Bt horizon in some pedons.

Lagunita Series

Depth class: very deep
Drainage class: excessively drained
Landform: flood plains
Parent material: sandy stream alluvium.
Slope range: 0 to 2 percent
Elevation: 1,200 to 1,400 feet
Classification: mixed, hyperthermic Typic Torripsamments

Typical Pedon

Lagunita silt loam, 0 to 2 percent slopes about 2,125 feet east and 900 feet south of the NW corner of sec. 36, T.3 S., R.5 E.

Cz1—0 to 1 inch; pale brown (10YR 6/3) stratified silt loam, dark yellowish brown (10YR 4/4) moist; moderate very fine platy structure; soft, very friable, sticky and plastic; many very fine roots; few very fine vesicular pores; violently effervescent; moderately saline (ECe 11 dS/m); moderately alkaline (pH 8.2); abrupt smooth boundary.

Cz2—1 to 6 inches; light yellowish brown (10YR 6/4) stratified loamy sand, dark yellowish brown (10YR 4/4) moist; weak very fine platy structure; soft, very friable; many very fine roots; many very fine irregular pores; violently effervescent; moderately saline (ECe 12 dS/m); moderately alkaline (pH 8.2); abrupt smooth boundary.

Cz3—6 to 8 inches; pale brown (10YR 6/3) stratified sand, yellowish brown (10YR 5/4) moist; single grain; loose; many very fine roots; many very fine irregular pores; slightly effervescent; moderately saline (ECe 12 dS/m); moderately alkaline (pH 8.4); abrupt smooth boundary.

Cz4—8 to 11 inches; pale brown (10YR 6/3) stratified loamy fine sand, dark yellowish brown (10YR 4/4) moist; weak very fine platy structure; soft, very friable; few very fine roots; many very fine irregular pores; violently effervescent, moderately saline (ECe 13 dS/m); moderately alkaline (pH 8.2); abrupt smooth boundary.

Cz5—11 to 60 inches; pale brown (10YR 6/3) stratified coarse sand, brown (10YR 5/3) moist; single grain; loose; few very fine roots; many very fine irregular pores; slightly effervescent; moderately saline (ECe 10 dS/m); mildly alkaline (pH 7.8).

Range in Characteristics

Cz1 horizon:
Color—brown, pale brown or light yellowish brown
Effervescence—slightly to violently effervescent
Salinity (ECe)—4 to 12 dS/m

Cz horizons:
Texture—stratified loamy sand, sand and coarse sand
Color—pale brown or light yellowish brown
Effervescence—slightly to violently effervescent
Salinity (ECe)—8 to 16 dS/m
Reaction—mildly to moderately alkaline

Laveen Series

Depth class: very deep
Drainage class: well drained
Landform: stream terraces
Parent material: loamy stream alluvium
Slope range: 0 to 2 percent
Elevation: 1,000 to 1,250 feet
Classification: coarse-loamy, mixed, hyperthermic Typic Calciorthids

Typical Pedon

Laveen fine sandy loam, saline-sodic, 0 to 2 percent slopes about 400 feet west and 400 feet south of the NE corner of sec. 11, T.1 S., R.1 E.

Anz—0 to 3 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak very thick platy structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; common very fine irregular pores; violently effervescent; strongly alkaline (pH 8.6); very slightly saline (ECe 2 dS/m); slightly sodic (SAR less than 10); clear smooth boundary.

Bwnz—3 to 11 inches; light yellowish brown (10YR 6/4) loam, dark yellowish brown (10YR 4/4) moist; strong very coarse and coarse angular blocky structure; hard, very friable, slightly sticky and slightly plastic; few very fine, fine and coarse roots; few very fine and fine tubular and irregular pores; few fine, rounded, soft accumulations of lime (12 percent $CaCO_3$); violently effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 37 dS/m) and strongly sodic (SAR 219); gradual wavy boundary.

Bknz1—11 to 29 inches; very pale brown (10YR 7/4) loam, yellowish brown (10YR 5/6) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, sticky and plastic; common very fine tubular and irregular pores; 5 percent nodules; common medium and coarse, rounded, soft accumulations of lime (22 percent $CaCO_3$); violently effervescent; very strongly alkaline (pH 9.4); strongly saline (ECe 48 dS/m) and strongly sodic (SAR 145); gradual wavy boundary.

Bknz2—29 to 60 inches; very pale brown (10YR 7/4) loam, yellowish brown (10YR 5/6) moist; moderate medium subangular blocky structure; hard, very friable, sticky and plastic; many very fine and fine tubular and irregular pores; 5 percent nodules; many coarse and very coarse, rounded and cylindrical, soft and hard accumulations of lime (36 percent $CaCO_3$); violently effervescent; very strongly alkaline (pH 9.2); strongly saline (ECe 30 dS/m) and strongly sodic (SAR 81).

Range in Characteristics

Depth to the calcic horizon: 3 to 30 inches
Average content of nodules in the control section: ranges from 0 to 40 percent by volume but averages less than 15 percent.

A horizon:
Salinity (ECe)—less then 4 dS/m
Sodicity (SAR)—less than 10
Reaction—moderately to very strongly alkaline

B horizon
Salinity (ECe)—10 to 49 dS/m
Sodicity (SAR)—81 to 220
Reaction—strongly or very strongly alkaline
Calcium carbonate equivalent—7 to 36 percent

Lomitas Series

Depth class: very shallow and shallow
Drainage class: somewhat excessively drained
Landform: hills and mountains
Parent material: colluvium from basalt and other volcanic rocks
Slope range: 15 to 65 percent
Elevation: 1,500 to 2,500 feet
Classification: loamy-skeletal, mixed, hyperthermic Lithic Camborthids

Typical Pedon

Hyder extremely cobbly loam in an area of Pompeii-Lomitas-Rock outcrop complex, 15 to 65 percent slopes about 2,050 feet west and 2,100 feet south of the NE corner of sec. 35, T.3 S., R.6 E.

A—0 to 2 inches; brown (10YR 5/3) extremely cobbly loam, dark yellowish brown (10YR 4/4) moist; weak very fine subangular blocky structure; soft, very friable, slightly sticky; slightly plastic; many very fine roots; many very fine irregular pores; noneffervescent; mildly alkaline (pH 7.8); clear smooth boundary.

Bw1—2 to 9 inches; brown (7.5YR 5/4) very cobbly loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; soft, very friable, sticky, plastic; many very fine roots; common very fine tubular discontinuous pores; noneffervescent; mildly alkaline (pH 7.8); abrupt wavy boundary.

Bw2—9 to 17 inches; brown (7.5YR 5/4) very cobbly loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; soft, very friable, sticky, plastic; many very fine roots; common very fine tubular discontinuous pores; noneffervescent; mildly alkaline (pH 7.8); abrupt wavy boundary.

2R—17 inches; basalt.

Range in Characteristics

Depth to bedrock: 10 to 20 inches
Average content of rock fragments in the control section: more than 35 percent

A horizon:
Effervescence—dominantly noneffervescent but is slightly effervescent in some pedons

B horizons:
Effervescence—dominantly noneffervescent; some pedons are slightly to strongly effervescent.

Momoli Series

Depth class: deep and very deep
Drainage class: somewhat excessively drained
Landform: high fan terraces
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 1 to 15 percent
Elevation: 1,100 to 1,800 feet
Claffication: loamy-skeletal, mixed, hyperthermic Typic Camborthids

Typical Pedon

Momoli cobbly sandy loam, 5 to 15 percent slopes about 1,500 feet north and 2,000 feet west of the SE corner of sec. 5, T.3 S., R.2 E.

A—0 to 2 inches; light yellowish brown (10YR 6/4) cobbly sandy loam, dark yellowish brown (10YR 4/4) moist; moderate very thin platy structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many very fine tubular pores; 50 percent fine gravel; noneffervescent; mildly alkaline (pH 7.6); clear smooth boundary.

Bw—2 to 15 inches; reddish yellow (7.5YR 6/6) very gravelly sandy loam, strong brown (7.5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many very fine tubular pores; 50 percent fine gravel and 5 percent cobbles; noneffervescent; mildly alkaline (pH 7.8); clear wavy boundary.

Bk—15 to 43 inches; reddish yellow (7.5YR 6/6) extremely gravelly loam, strong brown (7.5YR 4/6) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine and fine and few medium roots; many very fine tubular pores; 60 percent lime-coated fine, medium, and coarse gravel and 20 percent cobbles; slightly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

2Btkb—43 to 60 inches; reddish yellow (5YR 6/6) very gravelly sandy clay loam, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; hard, very friable, sticky and plastic; common very fine tubular pores; many prominent clay skins bridging sand grains; 50 percent lime-coated fine, medium, and coarse gravel; strongly effervescent; mildly alkaline (pH 7.8).

Range in Characteristics

Average content of rock fragments in the control section: more than 35 percent

The A horizon has 40 to 80 percent gravel and 5 to 30 percent cobble.

B horizon:

Texture—very gravelly sandy loam, extremely gravelly sandy loam or extremely gravelly loam

Color—reddish yellow, light yellowish brown or pale brown

Effervescence—noneffervescent to violently effervescent

Some pedons have a hardpan at depths greater than 40 inches, and others do not have a buried argillic horizon.

Pahaka Series

Depth class: very deep
Drainage class: well drained
Landform: fan terraces
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 1 to 5 percent
Elevation: 1,000 to 1,450 feet
Classification: coarse-loamy, mixed, hyperthermic Typic Camborthids

Typical Pedon

Pahaka loam in an area of Denure-Pahaka complex, 1 to 3 percent slopes about 200 feet north and 1,000 feet west of the SE corner of sec. 4, T.2 S., R.3 E.

A1—0 to 1 inch; light yellowish brown (10YR 6/4) loam, dark yellowish brown (10YR 4/4) moist; moderate medium platy structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; common very fine vesicular pores; 5 percent fine gravel; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

A2—1 to 4 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; moderate medium and coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; common very fine vesicular pores; 5 percent fine gravel; noneffervescent; moderately alkaline (pH 8.0); clear wavy boundary.

AB—4 to 9 inches; reddish yellow (7.5YR 6/6) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium and coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; 5 percent lime-coated fine gravel; noneffervescent; moderately alkaline (pH 8.2); clear wavy boundary.

Bwn—9 to 19 inches; reddish yellow (7.5YR 6/6) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; common very fine irregular pores; 14 percent lime-coated fine and medium gravel; strongly effervescent; moderately alkaline (pH 8.4); slightly sodic (SAR 11); gradual smooth boundary.

Bwnz—19 to 34 inches; reddish yellow (7.5YR 6/6) gravelly sandy loam, dark brown (7.5YR 4/4) moist; weak medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; 18 percent lime-coated fine and medium gravel; few very fine, rounded, soft accumulations of lime; strongly effervescent; moderately alkaline (pH 8.4); slightly saline (ECe 7 dS/m); moderately sodic (SAR 23); clear wavy boundary.

2Btknzb—34 to 46 inches; yellowish red (5YR 5/6) very gravelly sandy clay loam, yellowish red (5YR 4/6) moist; strong fine, medium, and coarse subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; many very fine tubular pores; many distinct clay skins on ped faces and bridging mineral grains; 47 percent lime-coated fine and medium gravel; many very fine, fine and medium, rounded and irregular, soft accumulations of lime; strongly effervescent; moderately alkaline (pH 8.4); moderately saline (ECe 9 dS/m), moderately sodic (SAR 27); gradual wavy boundary.

2Bknzb—46 to 60 inches; pink (7.5YR 7/4) strongly cemented gravelly sandy clay loam, brown (7.5YR 5.4) moist; moderate fine and medium subangular blocky structure; extremely hard, firm, sticky and plastic; few very fine tubular pores; 32 percent lime-coated medium gravel; many fine and medium, irregular and rounded, hard accumulations of lime; violently effervescent; moderately alkaline (pH 8.4); moderately saline (ECe 11 dS/m); moderately sodic (SAR 20).

Range in Characteristics

Depth to a buried argillic horizon: 20 to 40 inches (weakly to strongly cemented in some pedons)
Average content of rock fragments in the control

section: less than 35 percent (may exceed more than 35 percent in any single horizon)

A horizon:

Texture—loam, fine sandy loam or very gravelly fine sandy loam

Color—light brown, very pale brown or light yellowish brown

Effervescence—noneffervescent to violently effervescent

B horizon:

Texture—fine sandy loam, sandy loam, gravelly sandy loam, gravelly loam, or very gravelly sandy loam

Color—very pale brown, light yellowish brown, or reddish yellow

Effervescence—slightly to violently effervescent

Salinity (ECe)—1 to 7 dS/m

Sodicity (SAR)—1 to 23

2B horizons:

Texture—loam, sandy clay loam, gravelly loam, gravelly sandy clay loam, gravelly clay loam or very gravelly sandy clay loam

Color—light reddish brown, reddish brown, reddish yellow, pink, yellowish red or strong brown

Effervescence—slightly to violently effervescent

Salinity (ECe)—1 to 12 dS/m

Sodicity (SAR)—1 to 27

Reaction—moderately or strongly alkaline

Pinamt Series

Depth class: very deep
Drainage class: well drained
Landform: fan terraces
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 1 to 5 percent
Elevation: 1,100 to 1,800 feet.
Classification: loamy-skeletal, mixed, hyperthermic Typic Haplargids

Typical Pedon

Pinamt very gravelly loam in an area of Carrizo-Pinamt complex, 1 to 5 percent slopes about 700 feet north and 1,200 feet east of the SW corner of sec. 1, T.3 S., R.6 E.

A—0 to 3 inches; light yellowish brown (10YR 6/4) very gravelly loam, dark yellowish brown (10YR 4/4) moist; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine vesicular pores; 50 percent gravel; noneffervescent; mildly alkaline (pH 7.6) abrupt wavy boundary.

Bt1—3 to 8 inches; red (2.5YR 5/6) extremely gravelly sandy clay loam, red (2.5YR 4/6) moist; moderate fine subangular blocky structure; hard, very friable, sticky and plastic; many very fine roots; few very fine tubular pores; many prominent clay skins bridging and coating mineral grains; 70 percent gravel; noneffervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Bt2—8 to 27 inches; reddish yellow (5YR 6/8) cobbly coarse sandy loam, yellowish red (5YR 5/8) moist; moderate fine and medium subangular blocky structure; very hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; many prominent clay skins bridging mineral grains; 30 percent gravel and cobble; slightly effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

2Ck1—27 to 36 inches; reddish yellow (7.5YR 6/6) extremely gravelly loamy coarse sand, strong brown (7.5YR 5/6) moist; massive; very hard, very friable, nonsticky and nonplastic; common very fine tubular pores; 70 percent lime-coated gravel and cobble; few very fine irregular accumulations of lime; slightly effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

2Ck2—36 to 60 inches; light yellowish brown (10YR 6/4) extremely gravelly coarse sand, yellowish brown (10YR 5/4) moist; single grain; loose; nonsticky and nonplastic; 80 percent lime-coated gravel and cobble; noneffervescent in fine earth fraction; moderately alkaline (pH 8.4).

Range in Characteristics

Average content of rock fragments in the control section: more than 35 percent gravel and cobble (range from 15 to 80 percent)

A horizon:

Color—very pale brown, reddish yellow or light yellowish brown

Reaction—mildly or moderately alkaline

B horizon:

Texture—sandy clay loam, coarse sandy loam, sandy loam or loam

Color—red, reddish yellow, yellowish red or reddish brown

Effervescence—noneffervescent to slightly effervescent

Reaction—mildly or moderately alkaline

Clay content averages more than 18 percent in the control section.

Some pedons have an indurated hardpan at depths of 40 inches or more.

Some pedons have strata of loamy coarse sand, coarse sand, sandy loam or fine sandy loam below the control section.

Pompeii Series

Depth class: shallow (to a hardpan)
Drainage class: somewhat excessively drained
Landform: fan terraces
Parent material: colluvium from basalt
Slope range: 15 to 50 percent
Elevation: 1,500 to 2,500 feet
Classification: loamy-skeletal, mixed, hyperthermic, shallow Typic Paleorthids

Typical Pedon

Pompeii extremely cobbly sandy loam in an area of Pompeii-Lomitas-Rock outcrop complex, 15 to 65 percent slopes about 1,500 feet west and 150 feet south of NE corner of sec. 35, T.3 S., R.6 E.

A—0 to 2 inches; yellowish brown (10YR 5/4) extremely cobbly sandy loam; dark brown (10YR 3/3) moist; weak fine platy structure; soft, very friable; few very fine roots; few very fine vesicular pores; noneffervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw—2 to 9 inches; light brown (7.5YR 6/4) very gravelly sandy loam; dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; common very fine roots matted around stones; few very fine discontinuous tubular pores; noneffervescent; mildly alkaline (pH 7.8); clear wavy boundary.

Bk—9 to 13 inches; brown (7.5YR 5/4) very gravelly sandy loam; dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; few very fine roots; few very fine discontinuous tubular pores; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

2Bkm—13 inches; pinkish white (7.5YR 8/2) indurated lime-cemented hardpan.

Range in Characteristics

Depth to the petrocalcic horizon: 10 to 20 inches
Average content of rock fragments in the control section: range from 35 to 85 percent

Quilotosa Series

Depth class: very shallow and shallow
Drainage class: somewhat excessively drained
Landform: hills and mountains
Parent material: loamy alluvium and colluvium derived dominantly from granite
Slope range: 5 to 65 percent
Elevation: 1,150 to 3,100 feet
Classification: loamy-skeletal, mixed (calcareous), hyperthermic Lithic Torriorthents

Typical Pedon

Quilotosa extremely gravelly sandy loam in an area of Quilotosa-Rock outcrop-Vaiva complex, 20 to 65 percent slopes about 1,300 feet north and 600 feet east of the SW corner of sec. 2, T.3 S., R.6 E.

A—0 to 1 inch; yellowish brown (10YR 5/4) extremely gravelly sandy loam, dark brown (10YR 4/3) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine vesicular pores; more than 60 percent gravel; noneffervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

Bw—1 to 9 inches; brown (7.5YR 5/4) extremely gravelly sandy loam, dark brown (7.5YR 4/4) moist; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and few fine roots; common very fine vesicular pores; more than 60 percent gravel; noneffervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

Crtk—9 to 16 inches; pink (7.5YR 8/4) partially weathered granitic rock; common very fine roots; few distinct clay skins coating bedrock and in fractures; few distinct lime coatings in fractures; diffuse boundary.

R—16 inches; granite.

Range in Characteristics

Depth to unweathered bedrock: 4 to 20 inches
Average content of rock fragments in the control section: more than 35 percent

A horizon:
- Texture—very gravelly coarse sandy loam or extremely gravelly sandy loam
- Color—yellowish brown or light yellowish brown
- Effervescence—noneffervescent to slightly effervescent

B horizon:
- Texture—very gravelly sandy loam, extremely gravelly sandy loam, very gravelly loam or cobbly loam
- Color—light yellowish brown or brown
- Effervescence—noneffervescent to slightly effervescent

Cr horizon:
Texture—The Cr horizon is partially weathered granite that has the texture and structure of the underlying granite, but is easily fractured by hand or hammer. It has lime and clay coatings on fracture faces in most pedons.

Redun Series

Depth class: very deep
Drainage class: well drained
Landform: high stream terraces and fan terraces
Parent material: loamy stream alluvium and fan alluvium
Slope range: 0 to 3 percent
Elevation: 1,000 to 1,250 feet
Classification: coarse-loamy, mixed, hyperthermic Natric Camborthids

Typical Pedon

Typical pedon of Redun fine sandy loam in an area of Shontik-Redun complex, 0 to 3 percent slopes about 2,600 feet north and 1,300 feet east of the SW corner of sec. 34, T.3 S., R.3 E.

Anz—0 to 6 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few fine vesicular pores; noneffervescent; moderately alkaline (pH 8.2); slightly saline (ECe 7 dS/m) and strongly sodic (SAR 49); clear smooth boundary.

Bwnz—6 to 12 inches; strong brown (7.5YR 5/6) sandy loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common very fine, few fine and medium roots; few very fine vesicular pores; few fine, rounded, soft accumulations of lime and salt; violently effervescent; moderately alkaline (pH 8.4); strongly saline (ECe 40 dS/m) and strongly sodic (SAR 85); gradual wavy boundary.

Bnz1—12 to 24 inches; strong brown (7.5YR 5/6) sandy loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine and common fine vesicular pores; few coarse, rounded, soft accumulations of lime and salt; violently effervescent; strongly alkaline (pH 8.6); strongly saline (ECe 35 dS/m) and strongly sodic (SAR 132); gradual wavy boundary.

Bnz2—24 to 42 inches; strong brown (7.5YR 5/6) sandy loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; few medium roots; common very fine vesicular pores; few fine, irregular, soft accumulations of lime and salt; violently effervescent; strongly alkaline (pH 8.6); strongly saline (ECe 30 dS/m) and strongly sodic (SAR 84); gradual irregular boundary.

Bknz—42 to 60 inches; reddish yellow (7.5YR 6/6) fine sandy loam, strong brown (7.5YR 5/6) moist; weak medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; few very fine pores; many medium, irregular, soft accumulations of lime and salt; violently effervescent; strongly alkaline (pH 8.6); strongly saline (ECe 44 dS/m) and strongly sodic (SAR 96).

Range in Characteristics

Depth to a buried argillic horizon: 40 inches or more in some pedons
Average content of rock fragments in the control section: less than 35 percent (ranges from 5 to 50 percent)

A horizon:
Color—light brown, pale brown, light yellowish brown, yellowish brown, brownish yellow or reddish yellow
Effervescence—noneffervescent to violently effervescent
Salinity (ECe)—1 to 7 dS/m
Sodicity (SAR)—4 to 50
Reaction—moderately to strongly alkaline

B horizon:
Texture—sandy loam, fine sandy loam, gravelly sandy loam, coarse sandy loam or gravelly coarse sandy loam
Color—brown, strong brown, light brown and reddish yellow
Effervescence—strongly or violently effervescent
Salinity (ECe)—5 to 45 dS/m
Sodicity (SAR)—45 to 132
Reaction—moderately to very strongly alkaline
Some pedons are not saline or sodic.
Some pedons contain thin strata of sand or loamy sand.

Rillito Series

Depth class: very deep
Drainage class: somewhat excessively drained
Landform: high fan terraces
Parent material: loamy fan alluvium derived dominantly from granite and schist

Slope range: 3 to 15 percent
Elevation: 1,100 to 1,500 feet
Classification: coarse-loamy, mixed, hyperthermic Typic Calciorthids

Typical Pedon

Typical pedon of Rillito gravelly sandy loam is an area of Rillito-Gunsight complex, 3 to 15 percent slopes about 100 feet east and 2,000 feet north of the SW corner of sec. 10, T.3 S., R.2 E.

A—0 to 1 inch; yellow (10YR 7/6) gravelly sandy loam, yellowish brown (10YR 5/6) moist; moderate very thin platy structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; many very fine tubular pores; 25 percent fine, medium, and coarse gravel; violently effervescent (25 percent $CaCO_3$); moderately alkaline (pH 8.4); abrupt wavy boundary.

Bk1—1 to 10 inches; white (10YR 8/2) gravelly sandy loam, very pale brown (10YR 7/4) moist; strong coarse platy structure; hard, very friable, nonsticky and nonplastic; many very fine and common fine and medium roots; few very fine tubular pores; 20 percent lime-coated fine gravel; violently effervescent (35 percent $CaCO_3$); moderately alkaline (pH 8.4); gradual wavy boundary.

Bk2—10 to 28 inches; white (10YR 8/2) very gravelly sandy loam, very pale brown (10YR 7/4) moist; massive; hard, friable, nonsticky and slightly plastic; many very fine roots in upper part and few very fine in lower part; few very fine tubular pores; 40 percent lime-coated fine gravel; violently effervescent (35 percent $CaCO_3$); very strongly alkaline (pH 9.4); gradual wavy boundary.

Bk3—28 to 45 inches; light yellowish brown (10YR 6/4) gravelly loam, dark yellowish brown (10YR 4/4) moist; massive; hard, very friable, slightly sticky and slightly plastic; common very fine tubular pores; 15 percent lime-coated fine gravel; violently effervescent (30 percent $CaCO_3$); very strongly alkaline (pH 9.6); abrupt wavy boundary.

Bk4—45 to 60 inches; very pale brown (10YR 8/3) loam, brownish yellow (10YR 6/6) moist; massive; hard, very friable, slightly sticky and slightly plastic; few very fine tubular pores; violently effervescent (30 percent $CaCO_3$) ; very strongly alkaline (pH 9.4).

Range in Characteristics

Depth to the calcic horizon: 3 to 20 inches
Average content of calcium carbonate equivalent in the control section: less than 40 percent (ranges from 22 to 62 percent
Some pedons are saline and sodic.

Rositas Series

Depth class: very deep
Drainage class: somewhat excessively drained
Landform: sand dunes
Parent material: eolian
Slope range: 0 to 15 percent
Elevation: 1,000 to 1,200 feet
Classification: mixed, hyperthermic Typic Torripsamments

Typical Pedon

Typical pedon of Rositas sand in an area of Rositas-Casa Grande-Slickspots complex, 1 to 15 percent slopes about 1,650 feet east and 2,200 feet north of the SW corner of sec. 32, T.3 S., R.3 E.

Cn1—0 to 8 inches; very pale brown (10YR 7/4) sand, yellowish brown (10YR 5/6) moist; weak very thin platy structure; soft, very friable; many very fine roots; many very fine irregular pores; slightly effervescent; strongly alkaline (pH 8.8); slightly sodic; gradual smooth boundary.

Cn2—8 to 21 inches; yellow (10YR 7/6) sand, yellowish brown (10YR 5/6) moist; single grain; soft, very friable; many very fine, few coarse and fine roots; many very fine irregular pores; noneffervescent; strongly alkaline (pH 8.8);
slightly sodic; gradual smooth boundary.

Cn3—21 to 46 inches; brownish yellow (10YR 6/6) fine sand; yellowish brown (10YR 5/6) moist; single grain; soft, very friable; common very fine and fine roots; many very fine irregular pores; strongly effervescent; strongly alkaline (pH 8.8); slightly sodic; clear smooth boundary.

Cn4—46 to 60 inches; yellow (10YR 7/6) loamy fine sand, yellowish brown (10YR 5/6) moist; massive; hard, very friable; few very fine roots; many very fine tubular pores; violently effervescent; very strongly alkaline (pH 9.6); slightly sodic; gradual wavy boundary.

Range in Characteristics

*Depth to buried horizon:*40 inches or more in some pedons

C horizons:
Texture—cross-bedded, stratified sand, fine sand, loamy fine sand or very fine sand
Effervescence—noneffervescent to violently effervescent
Salinity (ECe)—less than 2 dS/m
Sodicity (SAR)—1 to 10
Reaction—moderately to very strongly alkaline

Shontik Series

Depth class: very deep
Drainage class: well drained
Landform: high stream terraces and low fan terraces
Parent material: loamy stream alluvium and fan alluvium
Slope range: 0 to 3 percent
Elevation: 1,000 to 1,250 feet
Classification: fine-loamy, mixed, hyperthermic Natric Camborthids

Typical Pedon

Typical pedon of Shontik fine sandy loam in an area of Shontik-Redun complex, 0 to 3 percent slopes about 1,500 feet west and 200 feet north of the SE corner of sec. 3, T.3 S., R.3 E.

A—0 to 1 inch; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak very thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine and common fine roots; many very fine tubular pores; strongly effervescent (3 percent $CaCO_3$); moderately alkaline (pH 8.2); very slightly saline (ECe 2 dS/m) and slightly sodic (SAR 1); abrupt smooth boundary.

Anz—1 to 9 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and few fine tubular pores; violently effervescent (6 percent $CaCO_3$); moderately alkaline (pH 8.2); slightly saline (ECe 7 dS/m) and moderately sodic (SAR 24); clear smooth boundary.

Bwn1—9 to 16 inches; reddish yellow (7.5YR 6/6) fine sandy loam, strong brown (7.5YR 4/6) moist; moderate fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; many very fine tubular pores; violently effervescent (9 percent $CaCO_3$); very strongly alkaline (pH 9.6); strongly saline (ECe 20 dS/m) and strongly sodic (SAR 50); clear smooth boundary.

Bwn2—16 to 28 inches; reddish yellow (7.5YR 6/6) fine sandy loam, strong brown (7.5YR 4/6) moist; weak coarse prismatic structure parting to moderate fine, medium, and coarse subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine tubular pores; common fine, irregular, soft accumulations of lime and salt; violently effervescent (9 percent $CaCO_3$); very strongly alkaline (pH 9.6), strongly saline (ECe 20 dS/m) and strongly sodic (SAR 80); clear wavy boundary.

2Btknzb1—28 to 34 inches; light reddish brown (5YR 6/4) clay loam, brown (7.5YR 5/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, very sticky and plastic; few very fine roots; many very fine tubular pores; common distinct colloidal stains on mineral grains; many fine and medium, rounded, soft accumulations of lime; violently effervescent (18 percent $CaCO_3$); very strongly alkaline (pH 9.4); strongly saline (ECe 20 dS/m) and strongly sodic (SAR 74); clear wavy boundary.

Btknzb2—34 to 50 inches; light reddish brown (5YR 6/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, very sticky and plastic; few very fine roots; many very fine tubular pores; common distinct colloidal stains and few distinct clay films bridging mineral grains; many fine and medium, rounded, soft accumulations of lime; violently effervescent (19 percent $CaCO_3$); very strongly alkaline (pH 9.4); strongly saline (ECe 26 dS/m) and strongly sodic (SAR 74); abrupt smooth boundary.

2Btknzb3—50 to 60 inches; light brown (7.5YR 6/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; hard, very friable, very sticky and very plastic; many very fine tubular pores; few distinct clay skins bridging mineral grains; many medium, rounded, soft accumulations of lime; violently effervescent (9 percent $CaCO_3$); very strongly alkaline (pH 9.4); strongly saline (ECe 23 dS/m) and strongly sodic (SAR 76).

Range in Characteristics

Depth to a buried argillic horizon: 20 to 40 inches (typically 24 to 35 inches)
Average content of rock fragments in the control section: less than 35 percent (ranges from 0 to 50 percent)

A horizon:
Color—light brown, brown, yellowish brown or light yellowish brown
Effervescence—noneffervescent to violently effervescent
Salinity (ECe)—1 to 12 dS/m
Sodicity (SAR)—1 to 24
Reaction—mildly to very strongly alkaline

B horizon:
Texture—fine sandy loam, sandy loam, gravelly sandy loam, and sandy clay loam

Color—light brown, light yellowish brown, yellowish brown or strong brown.
Effervescence—strongly or violently effervescent
Salinity (ECe)—5 to 41 dS/m
Sodicity (SAR)—45 to 95
Reaction—strongly or very strongly alkaline

2B horizons:
Texture—loam, sandy clay loam and clay loam
Color—light brown, very pale brown, strong brown, reddish brown, reddish yellow, yellowish red or light yellowish brown
Salinity (ECe)—14 to 38 dS/m
Sodicity (SAR)—73 to 100
Reaction—strongly or very strongly alkaline
Calcium carbonate equivalent—5 to 19 percent

Tatai Series

Depth class: very deep
Drainage class: well drained
Landform: high stream terraces
Parent material: silty and loamy stream alluvium
Slope range: 0 to 2 percent
Elevation: 1,000 to 1,200 feet
Classification: fine-loamy, mixed, hyperthermic Typic Camborthids

Typical Pedon

Typical pedon of Tatai silt loam, 0 to 2 percent slopes about 1,200 feet north and 1,000 feet east of the SW corner of sec. 4, T.3 S., R.4 E.

A1—0 to 1 inch; light yellowish brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and plastic; many very fine roots; common very fine irregular pores; violently effervescent (4 percent $CaCO_3$); moderately alkaline (pH 8.4); very slightly saline (ECe2 dS/m); clear smooth boundary.

A2—1 to 6 inches; yellowish brown (10YR 5/4) silt loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; hard, very friable, sticky and plastic; many very fine roots; common very fine irregular pores; violently effervescent (5 percent $CaCO_3$); strongly alkaline (pH 8.8); very slightly saline (ECe 2 dS/m); slightly sodic (SAR 1); gradual wavy boundary.

Bwn—6 to 11 inches; light brown (7.5YR 6/4) silt loam, brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; common very fine and few fine roots; common very fine irregular pores; common fine, irregular, accumulations of salt; violently effervescent (7 percent $CaCO_3$); strongly alkaline (pH 8.6); slightly sodic (SAR 5); gradual wavy boundary.

Bwnz—11 to 21 inches; light brown (7.5YR 6/4) silt loam, brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; common very fine and few fine roots; common very fine irregular pores; common fine, irregular, accumulations of salt; violently effervescent (8 percent $CaCO_3$); strongly alkaline (pH 8.6); slightly saline (ECe 5 dS/m) and slightly sodic (SAR 11); gradual wavy boundary.

Cnz—21 to 24 inches; light yellowish brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; common very fine and few fine roots; common very fine tubular and irregular pores; many fine, irregular, accumulations of salt; violently effervescent (9 percent $CaCO_3$); moderately alkaline (pH 8.4); moderately saline (ECe 9 dS/m) and slightly sodic (SAR 12); abrupt smooth boundary.

2Btknzb1—24 to 31 inches; brown (7.5YR 5/4) loam, strong brown (7.5YR 4/6) moist; moderate medium subangular blocky structure; hard, very friable, sticky and plastic; few very fine and fine roots; common very fine tubular pores; few faint clay skins on ped faces; few fine, irregular, accumulations of salt; violently effervescent (5 percent $CaCO_3$); moderately alkaline (pH 8.2); moderately saline (ECe 11 dS/m) and slightly sodic (SAR 9); gradual wavy boundary.

2Btknzb2—31 to 41 inches; yellowish red (5YR 5/6) loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure; very hard, very friable, sticky and plastic; few very fine and fine roots; many very fine tubular pores; common prominent clay skins on ped faces and lining pores; many fine rounded and irregular, soft accumulations of lime and salt; violently effervescent (9 percent $CaCO_3$); moderately alkaline (pH 8.2); moderately saline (ECe 11 dS/m) and slightly sodic (SAR 6); gradual wavy boundary.

2Btknzb3—41 to 60 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; strong medium prismatic structure; extremely hard, friable, very sticky and very plastic; few very fine roots; many very fine and fine tubular pores; many prominent clay skins on ped faces and lining pores; many medium and coarse, rounded, soft accumulations of lime and salt; violently effervescent (14 percent $CaCO_3$); moderately alkaline (pH 8.2); moderately saline (ECe 9 dS/m) and slightly sodic (SAR 5).

Range in Characteristics

Depth to a buried argillic horizon: 20 to 40 inches (typically 22 to 38 inches)

A horizon:
Color—light yellowish brown or yellowish brown
Salinity (ECe)—1 to 5 dS/m
Sodicity (SAR)—2 to 18
Reaction—moderately or strongly alkaline

B horizon:
Texture—silt loam or loam
Color—light brown, strong brown or yellowish brown
Salinity (ECe)—2 to 20 dS/m
Sodicity (SAR)—7 to 22
Reaction—moderately to very strongly alkaline

C horizon:
Some pedons do not have a C horizon, and others have thin strata of finer or coarser material above the buried horizon.

2B horizons:
Texture—loam clay loam or sandy clay loam. Some pedons are clay in the lower part.
Color—brown, strong brown, reddish brown or yellowish red
Salinity (ECe)—5 to 16 dS/m
Sodicity (SAR)—4 to 19
Carbonate equivalent—5 to 14 percent

Trix Series

Depth class: very deep
Drainage class: well drained
Landform: flood plains
Parent material: loamy stream alluvium
Slope range: 0 to 1 percent
Elevation: 1,000 to 1,200 feet
Classification: fine-loamy, mixed (calcareous), hyperthermic Typic Torrifluvents

Typical Pedon

Typical pedon of Trix loam, saline-sodic, 0 to 1 percent slopes about 2,600 feet north of the SW corner of sec. 11, T.2 S., R.2 E.

Anz—0 to 5 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; strong fine subangular blocky structure; slightly hard, very friable, sticky and plastic; common very fine and few fine roots; many very fine tubular pores; violently effervescent; strongly alkaline (pH 8.8); slightly saline (ECe 5 dS/m) and strongly sodic; abrupt wavy boundary.

Cnz1—5 to 19 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, sticky and plastic; common very fine and fine roots; common fine tubular pores; few fine irregular accumulations of salt; violently effervescent; strongly alkaline (pH 8.8); strongly saline (ECe 18 dS/m) and strongly sodic; clear wavy boundary.

Cnz2—19 to 32 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 5/4) moist; weak very fine and fine subangular blocky structure; hard, very friable, sticky and plastic; common fine roots; common fine tubular pores; violently effervescent; very strongly alkaline (pH 9.4); moderately saline (ECe 14 dS/m) and strongly sodic; clear smooth boundary.

2Btknzb—32 to 60 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak very fine and fine subangular blocky structure; hard, very friable, sticky and very plastic; common very fine irregular pores; common thin clay films on faces of peds; common medium, rounded soft accumulations of lime, violently effervescent; strongly alkaline (pH 9.4); moderately saline (ECe 11 dS/m) and strongly sodic.

Range in Characteristics

Depth to a buried argillic horizon: 20 to 40 inches

A horizon:
Color—brown, light yellowish brown or very pale brown
Effervescence—strongly or violently effervescent
Salinity (ECe)—2 to 16 dS/m
Sodicity (SAR)—5 to 10
Reaction—moderately to very strongly alkaline

C horizons:
Texture—stratified loam, clay loam, sandy clay loam and silt loam
Color—brown, light brown, pale brown, very pale brown, light yellowish brown or reddish yellow
Effervescence—strongly or violently effervescent
Salinity (ECe)—10 to 24 dS/m
Sodicity (SAR)—10 to 220
Reaction—strongly or very strongly alkaline

2B horizon:
Texture—sandy clay loam or clay loam
Some pedons contain large accumulations of salt crystals.
Some pedons contain thin strata of finer or coarser material throughout.

Vaiva Series

Depth class: very shallow and shallow
Drainage class: well drained
Landform: hills and mountains
Parent material: loamy alluvium and colluvium derived dominantly from granite
Slope range: 1 to 25 percent
Elevation: 1,150 to 3,100 feet
Classification: loamy-skeletal, mixed, hyperthermic Lithic Haplargids

Typical Pedon

Typical pedon of Vaiva extremely gravelly sandy loam in an area of Quilotosa-Rock outcrop-Vaiva-complex, 20 to 65 percent slopes about 1,300 feet north and 500 feet east of the SW corner of sec. 2, T.3 S., R.6 E.

A—0 to 1 inch; yellowish brown (10YR 5/4) extremely gravelly sandy loam, dark brown (10YR 4/3) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine vesicular pores; 65 percent gravel; noneffervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Bt—1 to 8 inches; reddish brown (5YR 5/4) extremely gravelly sandy clay loam, reddish brown (5YR 4/4) moist; moderate medium granular structure; soft, very friable, slightly sticky and plastic; common very fine roots; many very fine vesicular pores; common distinct clay films on faces of peds and coating rock fragments; 70 percent gravel; noneffervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

Crt—-8 to 13 inches; reddish brown (5YR 5/4) highly weathered granitic rock; few very fine roots; many very fine vesicular pores; common distinct clay films coating rock fragments; 75 percent gravel; noneffervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

Crk—13 to 18 inches; reddish yellow (5YR 6/6) partially weathered granitic rock; few very fine roots; few distinct clay films coating bedrock and in fractures; few distinct lime coatings in fractures; diffuse boundary.

R—18 inches; granite.

Range in Characteristics

Depth to unweathered bedrock: less than 20 inches
Average content of rock fragments in the control section: more than 35 percent

A horizon:
Color—light yellowish brown or yellowish brown

B horizon:
Texture—extremely gravelly sandy clay loam or very gravelly loam
Color—reddish brown, reddish yellow or yellowish red
Effervescence—noneffervescent to slightly effervescent

Cr horizon:
Texture—The Cr horizon is partially weathered granite that has the texture and structure of the underlying granite, but is easily fractured by hand or hammer.
Effervescence—noneffervescent to strongly effervescent

Vint Series

Depth class: very deep
Drainage class: somewhat excessively drained
Landform: flood plains
Parent material: sandy stream alluvium
Slope range: 0 to 10 percent
Elevation: 940 to 1,400 feet
Classification: sandy, mixed, hyperthermic Typic Torrifluvents

Typical Pedon

Typical pedon of Vint loamy fine sand in an area of Gadsden, Glenbar and Vint soils, saline-sodic, 0 to 2 percent slopes about 2,300 feet south and 200 feet east of the NW corner of sec. 14, T.3 S., R.4 E.

C1—0 to 2 inches; pale brown (10YR 6/3), stratified loamy fine sand, brown (10YR 4/3) moist; weak thin platy structure; soft, very friable; common very fine roots; few very fine tubular discontinuous pores; violently effervescent; moderately alkaline (pH 8.0); very slightly saline (ECe 2 dS/m); clear smooth boundary.

C2—2 to 10 inches; pale brown (10YR 6/3), stratified silty clay loam, very dark brown (10YR 2/2) moist; moderate medium platy structure; slightly hard, very friable, sticky, plastic, many very fine roots; few very fine tubular discontinuous pores; violently effervescent; moderately alkaline (pH 8.2); very slightly saline (ECe 3 dS/m); abrupt smooth boundary.

Cz1—10 to 21 inches; light brownish gray (10YR 6/2) stratified loamy fine sand, with thin strata of silt loam, brown (10YR 4/3) moist; single grain; soft, very friable; common very fine roots; many very fine irregular pores; violently effervescent; moderately alkaline (pH 8.0); strongly saline (ECe 18 dS/m); clear smooth boundary.

Cz2—21 to 43 inches; light brownish gray (10YR 6/2) stratified fine sand with thin strata of very fine sandy loam, brown (10YR 4/3) moist; single grain; loose; few very fine roots; many very fine irregular pores; slightly effervescent; moderately alkaline (pH 8.0); moderately saline (ECe 13 dS/m); abrupt smooth boundary.

Cz3—43 to 48 inches; brown (10YR 4/3) stratified silty clay with thin lenses of sand; dark yellowish brown (10YR 3/4) moist; massive; hard, friable, sticky, plastic; few very fine roots; few very fine tubular discontinuous pores; violently effervescent; moderately alkaline (pH 8.2); moderately saline (ECe 10 dS/m); abrupt smooth boundary.

Cz4—48 to 60 inches; pale brown (10YR 6/3) stratified very fine sandy loam with thin lenses of sand, brown (10YR 4/3) moist; massive; soft, very friable; few very fine roots; few very fine tubular discontinuous pores; violently effervescent; moderately alkaline (pH 8.2); moderately saline (ECe 8.0 dS/m).

Range in Characteristics

C1 horizon:

Texture—fine sandy loam, loamy fine sand or fine sand
Color—very pale brown, pale brown, brown, light yellowish brown or yellowish brown
Effervescence—slightly to violently effervescent
Salinity (ECe)—1 to 4 dS/m
Sodicity (SAR)—1 to 10

C horizons:

Texture—stratified loamy fine sand and fine sand
Color—brown, pale brown or light brownish gray
Effervescence—slightly to violently effervescent
Salinity (ECe)—less than 1 to 18 dS/m
Sodicity (SAR)—1 to 25
Reaction—mildly to very strongly alkaline

Why Series

Depth class: very deep
Drainage class: somewhat excessively drained
Landform: alluvial fans
Parent material: loamy fan alluvium derived dominantly from granite and schist
Slope range: 0 to 2 percent
Elevation: 950 to 1,550 feet
Classification: coarse-loamy, mixed, hyperthermic Fluventic Camborthids

Typical Pedon

Typical pedon of Why coarse sand in an area of Why-Brios complex, 0 to 2 percent slopes about 2,100 feet east and 900 feet north of the southwest corner of sec. 12, T.5 S., R.5 E.

A—0 to 4 inches; very pale brown (10YR 7/3) stratified coarse sand, brown (10YR 5/3) moist; single grain; loose; common very fine roots; many very fine irregular pores; noneffervescent; 2 percent gravel; mildly alkaline (pH 7.7); abrupt wavy boundary.

Bw1—4 to 12 inches; light brown (7.5YR 6/4) stratified coarse sandy loam, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable; common very fine roots; many very fine irregular pores; slightly effervescent (2 percent $CaCO_3$); 10 percent gravel; moderately alkaline (pH 7.8); clear smooth boundary.

Bw2—12 to 18 inches; light brown (7.5YR 6/4) stratified gravelly coarse sandy loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable; few very fine roots; many very fine irregular pores; few calcium carbonate coatings on gravel; strongly effervescent (2.6 percent $CaCO_3$); 20 percent gravel; moderately alkaline (pH 7.9); abrupt smooth boundary.

Bk1—18 to 32 inches; light brown (7.5YR 6/4) gravelly coarse sandy loam, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable; few very fine roots; many very fine irregular pores; violently effervescent (3 percent $CaCO_3$); few fine calcium carbonate masses and coatings on gravel; 15 percent gravel; moderately alkaline (pH 8.1); abrupt smooth boundary.

Bk2—32 to 56 inches; light brown (7.5YR 6/4) coarse sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky; few very fine roots; many very fine tubular pores; violently effervescent (3.6 percent $CaCO_3$), few fine calcium carbonate masses and coatings on gravel; moderately alkaline (pH 8.1); abrupt smooth boundary.

2Bk—56 to 60 inches; very pale brown (10YR 7/4) gravelly coarse sandy loam, light yellowish brown (10YR 6/4) moist; massive; hard, very friable, slightly sticky; few fine roots; many very fine roots; many very fine tubular pores; violently effervescent (21.8 percent $CaCO_3$), horizon entirely engulfed by weakly cemented calcium carbonate; very slightly saline (ECe 2 dS/m); slightly sodic (SAR 12); strongly alkaline (pH 8.6).

Range in Characteristics

Depth to a Bk horizon: 15 to 30 inches

Average content of rock fragments in the control section: 5 to 30 percent

A horizon:
Salinity (ECe)—less than 1 to 8 dS/m
Sodicity (SAR)—1 to 13
Reaction—mildly to strongly alkaline

B horizon:
Texture—sandy loam or coarse sandy loam

Yahana Series

Depth class: very deep
Drainage class: well drained
Landform: flood plains
Parent material: silty stream alluvium
Slope range: 0 to 10 percent
Elevation: 940 to 1,400 feet
Classification: fine-silty, mixed, hyperthermic Typic Salorthids

Typical Pedon

Typical pedon of Yahana silty clay loam, 0 to 2 percent slopes about 600 feet west and 100 feet south of the NE corner of sec. 32, T.3 S., R.3 E.

Surface is covered by a 2-5 mm thick salt crust.

Anz—0 to 4 inches; brown (10YR 5/3) silty clay loam, dark brown (7.5YR 4/4) moist; strong very thick platy structure; slightly hard, very friable, very sticky and very plastic; many very fine vesicular pores; many fine salt crystals; strongly effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 48 dS/m) and strongly sodic (SAR 203); clear wavy boundary.

Bnz1—4 to 10 inches; brown (7.5YR 5/4) stratified silty clay, dark brown (7.5YR 4/4) moist; strong very fine granular structure; soft, very friable, very sticky and very plastic; few gypsum crystals; many fine salt crystals; slightly effervescent; strongly alkaline (pH 8.8); strongly saline (ECe 81 dS/m) and strongly sodic (SAR 389); gradual wavy boundary.

Bnz2—10 to 14 inches; strong brown (7.5YR 5/6) stratified silty clay, brown (7.5YR 5/4) moist; strong very fine granular structure; soft, very friable, very sticky and very plastic; many fine salt crystals; strongly effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 55 dS/m) and strongly sodic (SAR 203); gradual wavy boundary.

Cnz1—14 to 25 inches; light brown (7.5YR 6/4) stratified silty clay, brown (7.5YR 4/4) moist; strong medium granular structure; hard, very friable, very sticky and very plastic; few very fine roots; common very fine roots; common very fine vesicular pores; many fine salt crystals, violently effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 46 dS/m) and strongly sodic (SAR 211); clear smooth boundary.

Cnz2—25 to 33 inches; light brown (7.5YR 6/4) stratified silty clay loam, brown (7.5YR 5/4) moist, with many dark brown (7.5YR 3/2) manganese coatings on ped faces; massive; hard, very friable, sticky and plastic; few fine roots; common very fine vesicular pores; few fine salt crystals; violently effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 35 dS/m) and strongly sodic (SAR 325); clear smooth boundary.

Cnz3—33 to 58 inches; light yellowish brown (10YR 6/4) stratified silt loam, brown (7.5YR 5/4) moist, with many fine and medium, distinct, yellowish red (5YR 4/6) and pinkish gray (7.5YR 7/2) mottles; massive; slightly hard, very friable, slightly sticky and plastic; common very fine vesicular pores; violently effervescent; very strongly alkaline (pH 9.6); strongly saline (ECe 34 dS/m) and strongly sodic (SAR 393); clear smooth boundary.

Cnzc—58 to 60 inches; light yellowish brown (10YR 6/4) stratified loamy fine sand, brown (7.5YR 5/4) moist, with few fine and medium, faint, pink (7.5YR 7/4) mottles; massive; hard, very friable; few fine irregular pores; common coarse and very coarse rounded nodules; violently effervescent; very strongly alkaline (pH 9.6); strongly saline and strongly sodic.

Range in Characteristics

A horizon:
Texture—silty clay loam, fine sandy loam or silt loam
Color—very pale brown, pale brown, light brown, brown, light yellowish brown, grayish brown or white
Effervescence—strongly or violently effervescent
Salinity (ECe)—2 to 85 dS/m
Sodicity (SAR)—81 to 939
Reaction—moderately to very strongly alkaline

B horizon:
Texture—stratified silt loam, loam, silty clay loam and silty clay
Color—pale brown, brown, light yellowish brown, yellowish brown, strong brown and light brown
Effervescence—strongly or violently effervescent
Salinity (ECe)—22 to 87 dS/m
Sodicity (SAR)—78 to 389
Reaction—strongly or very strongly alkaline

C horizon:

Texture—stratified silt loam, loam, silty clay loam, very fine sandy loam, fine sandy loam and loamy fine sand
Color—light brown, reddish yellow, brown, light yellowish brown, pale brown, very pale brown, light reddish brown and pink
Effervescence—strongly or violently effervescent
Salinity (ECe)—22 to 62 dS/m
Sodicity (SAR)—20 to 394
Reaction—strongly or very strongly alkaline

The salic horizon is immediately below the surface horizon in most pedons. Salt percentage ranges from 2.2 to 6.0 percent. Most pedons have 1 to 2 mm strata of finer or coarser material throughout. Mottles are in most pedons.

Formation of the Soils

John D. Preston, Soil Scientist, Natural Resources Conservation Service, helped to prepare this section.

This section discusses the five soil forming factors of climate, living organisms, parent material, time, and relief. They will be discussed individually and as they relate to soils on specific landforms in the survey area.

Soil is formed through the interaction of the five soil forming factors. The relative influence of each factor varies from place to place, and in some places one factor dominates in the formation of a soil and determines most of its properties *(40)*. Variation in soils in the survey area is due mainly to difference in parent material, time, relief, and the effects of human influence on the soil.

Climate

Climate affects soil formation in numerous ways. Precipitation, temperature, and wind are some of the influencing factors of climate.

The present climate in the survey area is hot and dry. The low rainfall, less than 10 inches, is not sufficient to remove minerals such as calcium carbonate, salt, sodium, or gypsum entirely from the soil profiles. Rainfall has been quite low throughout the late Holocene and soil development has been minimal. Most soils can be expected to remain very much the same mineralogically unless acted upon by another soil forming factor.

Temperature affects soil formation by physically breaking down rock into parent material. Temperature fluctuations cause expansion and contraction to fracture and disintegrate rock.

Wind affects soil development by either removing or adding soil material or minerals to the profile. Soil particles are removed in some areas and deposited in other areas to form either sand dunes or coppice dunes. Theoretically, carbonates or salts can be added to a soil profile by the wind.

Most soil horizons were formed during the early Holocene times or earlier. These past climates were cooler and wetter and more conducive to the leaching of finer soil particles and minerals into distinct soil horizons.

Since the completion of the Coolidge Dam in 1929, the perennial flow of the Gila River has been halted through the survey area. This has led to a lowering of the water table in the survey area. This water table contributed gypsum, salts, carbonates, and sodium to many of the soils in the survey area. This is evidenced by distinct double "bulges," or accumulations of these minerals in the Kamato and Casa Grande soils found on the relict basin floor, The upper accumulation indicates leaching from the surface, and the lower bulge shows the results of accumulations from ground water. Another evidence of this is the presence of manganese or polygorskite, which forms only under wet or reducing conditions *(28)*.

Living Organisms

Plants stabilize soil and allow soil formation to take place. Plants can trap wind-borne soil particles, forming coppice dunes or stabilizing sand dunes. Plants can trap water-borne sediments, creating alluvial fans or increasing the size of flood plains. Some plants add nutrients or organic matter to the soil. Many of the soils in the survey area have higher amounts of organic carbon in the soil than would normally be expected. This indicates that in the past more vegetation was present in the survey area. This is well documented in historical accounts by early visitors to the survey area (see Range section). Destruction of vegetation leads to destruction of soil or soil erosion. On a small scale, this could mean areas of gullying or sheet erosion. On a large scale, such as has occurred along the Gila River in the survey area, loss of vegetation is one of the factors responsible for the downcutting and channelization of the Gila River.

Animal life contributes also to soil development. On a micro scale, the tunneling activities of cicadas, earthworms, and other burrowing insects can increase water permeability in the soil. Larger burrowing animals can mix or even entirely obliterate soil horizons. Large animals such as cattle and horses can denude areas of vegetation, leading to water or wind erosion. In areas of intense use by larger stock animals, large areas of soil may have the soil structure in the surface layer pulverized by the animals' hooves, leaving the soil susceptible to wind erosion. Animal trails often turn into gullies by water erosion.

Humans are by far the leading living organism in their effect on soil development. Upstream irrigation activities have stopped, for the most part, the former flow of the Gila River, drastically lowering the natural water table. Many of the soils within the San Carlos Irrigation District now have a thick dark cap of loam or clay loam from having been irrigated for many years with sediment-laden water. Reclamation activities have removed salts and sodium from many areas that were naturally saline and sodic. Land leveling has drastically altered the soil in many areas, in some places exposing buried horizons and in other areas burying soils. Cultivation mixes surface layers to varying depths. Certain crops remove nutrients from the soil while others add nutrients and organic matter to the soil.

Parent Material

Residuum is soil material that has remained in place after being weathered from rock. Soils formed from residuum are almost non-existent in the survey area. The only place residual soils are likely to be found is on old, stable positions on hills and mountains.

Colluvium is soil material that has been transported by gravity and local unconcentrated runoff. Soils formed from colluvium could be found on hills and mountains on steep, active slopes.

Eolian soil material has been transported by the wind. Most of the soils in the survey area have been affected by eolian soil material. Examples of this are coppice dunes, similar colors and textures of surface horizons in many soils, and probable additions of carbonates or other salts.

Most of the soils in the survey area, excluding those soils which are flooded, have an ochric epipedon that is remarkably similar in physical and chemical properties. Of the twenty typifying pedons of upland soils, 100 percent had hue of 10YR or 7.5YR, 85 percent had value of 6 or 7, and 85 percent had chroma of 4. Eighty-five percent of the pedons had textures of loam, fine sandy loam, or sandy loam. Most of these epipedons are low in carbonates, salt and sodium. These similarities indicate that these epipedons are a uniform (1 inch to 3 inches thick) eolian mantle and are late Holocene in age. In fact, with the drastic biologic and hydrologic changes of the past century, it is probable that this horizon is very contemporary.

Alluvium is material that has been transported and deposited by water. Many different types of alluvium are present in the survey area.

Slope alluvium is soil material that is transported on mountains or hills. Slope alluvium in complex with colluvium generally forms the soils found on active and metastable slopes on hills and mountains in the survey area.

Fan alluvium is soil material that has been removed from the hills and mountains and deposited originally as alluvial fans and then dissected to become fan terraces. Fan alluvium is generally episodic, that is the same type of material is deposited over a long period of time. Fan alluvium is also highly variable. Generally, fan alluvium tends to lose coarse fragments with greater distance from the mountains. Textures also grade finer downslopes.

Stream alluvium is soil material deposited by streams and rivers. Stream alluvium ranges in texture from sand, gravel, and cobbles to clay. Stream alluvium also tends to be relatively high (greater than 1 percent) in organic matter, salts, and sodium.

Basin alluvium consists of sediments and chemical precipitates originally deposited in lakes. Basin alluvium is generally moderately fine or fine textured and relatively free of rock fragments. Coarse fragments in basin alluvium are generally nodules of calcium carbonate, gypsum or other precipitates which tend to form under wet conditions. The basin alluvium in the survey area was deposited when the Gila River was naturally dammed between the Sierra Estrella and South Mountain.

Time

Time has no real effect on soil development. Time only gives the other factors of soil formation the opportunity to modify parent material into soil horizons. Soils can be classified according to four periods: Late Holocene, from the present to 5,000 years before present (B.P.); Early Holocene, from 5,000 to 10,000 year B.P. Late Pleistocene, from 10,000 to 250,000 years B.P.; and Early Pleistocene, more than 250,000 years B.P.

Relief

Relief influences soil formation primarily through its effect upon moisture runoff and run-on, and erosion *(15)*.

In general, on active slopes (greater than 45 percent), runoff is substantial and only small amounts of moisture enter the soil profile. Because moisture is essential to the weathering process, soils on active slopes have few developed soil horizons in these areas. The excess runoff often accelerates erosion to the point where soil is being removed faster than it is being weathered or deposited. Bedrock is often near the soil surface or may be entirely exposed as rock outcrop *(15)*.

On stable slopes (less than 15 percent), runoff is slow and greater amounts of moisture are allowed to enter the soil profile and to a greater depth. In some areas, run-on moisture is received from adjacent active slopes. Erosion is generally slight in these stable areas and soil development is generally well advanced *(15)*.

Metastable slopes (15 to 45 percent), have for the most part, medium runoff and moderate erosion. Soil development is generally not well expressed but is slowly occurring.

Soils on concave or nearly level areas often receive run-on moisture from adjacent sites. This often can accelerate soil development. However, if the run-on moisture is great enough and carries enough sediments, soil development may be destroyed or buried *(15)*.

Relief is very important to soil development but it must be remembered that present day relief may have been modified in the past. For example, soils with petrocalcic horizons may occur on active hills, but may have been raised into those positions by tectonic activity after forming on a more stable position.

Landforms

In this survey area, seven landforms predominate. They are flood plains, stream terraces, sand dunes, basin floors, alluvial fans, fan terraces, hills and mountains *(42)*. In this section the soil forming factors; principally parent material, time and relief; that interact on these landforms are discussed and illustrated with specific soils as examples.

Soils of flood plains

These landforms developed in recent alluvium deposited principally by the Gila River and Santa Cruz Wash.

Vint soils (Typic Torrifluvents) are typical of the lower flood plains of the Santa Cruz Wash and the Gila River downstream from the Gila Butte. Vint soils are very deep, stratified, and sandy *(fig. 14)*.

Brios soils (Typic Torrifluvents) are the dominant soils of the lower Gila River flood plain upstream from Gila Butte. These soils are very deep, stratified, and sandy. They are coarser textured than Vint soils.

Yahana (Typic Salorthids) soils are typical of the higher flood plain. These are very salty soils of former wet places where capillary rise and evaporation of water concentrate the salts into a salic horizon *(49)*. These soils formed under reducing conditions during short periods of floodings. The salic horizons, comprised mostly of sodium chloride, increase toward the surface, reaching almost 6 percent salt in one pedon *(27)*. This indicates that salts moved up in the profile from a former shallow saline water table.

Soils of Stream Terraces

These landforms border the flood plains. Shontik soils (Natric Camborthids) are typical of the stream terraces. These are two-story soils. Moderately coarse textured Holocene stream alluvium overlies moderately fine textured Pleistocene basin alluvium.

Soils of Sand Dunes

Rositas soils (Typic Torripsamments) occur on sand dunes. They are deep, windblown sands whose origin was the sandy soils of the nearby flood plains and eroded surfaces of basin floor soils.

Soils of Relict Basin Floors

The basin floors are characterized by broad alluvial flats containing ephemeral drainageways. Typic Natrargids such as Casa Grande and Kamato soils are the principal soils of the relict basin floors. They are similar, but Kamato soils are fine textured and have significant accumulations of gypsum in the clayey substratum. The reddish brown clays of the substratum are similar to those described by others as lake deposits. The manganese content and the absence of nitrate indicate that the profile was formerly wetter *(27)*.

Soils of Alluvial Fans

Alluvial fans are landforms that receive and accumulate sediment. They formed during the Holocene Epoch and are characterized by numerous braided streams and shallow channels from which water periodically overflowed and deposited alluvium on the surface.

Why soils (Fluventic Camborthids) are typical of soils on alluvial fans. The upper part of the profile is stratified and also exhibits an irregular decrease in organic matter with depth.

Soils of Fan Terraces

The fan terraces are broad coalescent plains that have been incised by washes. Soils of fan terraces formed during mid to late Pleistocene epochs.

The position of the fan terraces has influenced the soil properties and horizination of this landform. A typical soil landscape sequence is: Cavelt soils (Typic Paleorthids) on the highest fan terraces, Gunsight soils (Typic Calciorthids) on the intermediate positions, and Denure soils (Typic Camborthids) on the lowest fan terraces.

Chuckawalla soils (Typic Haplargids), exhibit a feature known as desert pavement. Desert pavement is a concentration of pebbles, generally subrounded, armoring the surface of the soil. The pebbles generally have a black coating on them called desert varnish or patina.

One theory on the origin of desert pavement is that the pebbles are lifted slightly when the soil is moistened, and the soil subsequently shrinks when it dries, forming cracks in the fine earth fraction. Pebbles cannot fall into these cracks but the soil particles can. If this process were repeated many times over thousands of years, the surface of the soil would gradually become paved, along with the accompanying underlying subsurface layer with little or no rock fragments in this. Freezing and thawing could also produce this effect. Since these processes occurred commonly in the past and the soils with desert pavement are generally Late Pleistocene in age, these processes are likely to be generally responsible for desert pavement formation *(14)*.

The second theory on the formation of desert pavement is that of deflation. Deflation is the concentration of pebbles on the surface due to erosion of fine earth *(14)*. This removal of soil particles causes the soil surface to be lowered, concentrating the coarse fragments in what was perhaps a foot or more of soil on the surface.

Desert varnish or patina is a thin black or dark red

Figure 15.—Soil profile of Pompeii extremely cobbly sandy loam soils. Thin solum overlies laminar-capped petrocalcic horizon.

coating which is found on the pebbles that comprise the desert pavement. Studies in the Mojave Desert indicate the varnish is more than 70 percent clay minerals. These studies also indicate the varnish material comes from sources other than the pebble itself because varnish is found on material such as quartz which could not have weathered the components. Clay dustfall is though to be a source in such instances *(14)*.

Local observations conclude that these processes are still active today. Indian pottery shards and even twentieth century metallic artifacts can be found interlocked within the desert pavement and varnished on the upper sides. Also of interest is the high content of salts and sodium in the paved soils. Data from the National Soil Survey Laboratory on desert pavement soils in adjacent and nearby surveys similar to those found in this survey area indicate typical SARs are from 15 to 30 or more; typical electroconductivity readings from 20 dS/m to over 100 dS/m; and total salts from 1. 5 to 3.0 percent *(24, 25, 26)*. It is thought these salts have accumulated in soils with desert pavement in much the same way that salts accumulate at the tops of seedbeds by capillary rise and evaporation in irrigated cropland *(13)*.
The desert pavement then armors the soil profile and protects the salts from leaching by rainfall by shedding the rainwater to adjacent non-paved areas.

Soils on Hills and Mountains

Quilotosa (Lithic Torriorthents) and Vaiva (Lithic Haplargids) soils are typical of the soils on granite hills of the Sierra Estrella and Sacaton Mountains. Vaiva soils are redder, have argillic horizons and typically occur on stable slopes while Quilotosa soils occur on metastable and active slopes. Lomitas (Lithic Camborthids) and Pompeii (Typic Paleorthids) soils are typical of soils on basalt hills in the San Tan Mountains. Lomitas soils overlie bedrock at shallow depths and occur on the upper portion of the hills. Pompeii soils overlie a petrocalcic horizon at shallow depths and occur on the lower portion of the hills (fig. 15).

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial cone. The material washed down the sides of mountains and hills by ephemeral streams and deposited at the mouth of gorges in the form of a moderately steep, conical mass descending equally in all directions from the point of issue.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Alpha,alpha-dipyridyl. A dye that when dissolved in 1N ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction indicates a type of redoximorphic feature.

Animal unit month (AUM). The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Area reclaim (in tables). 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 subsoil horizon characterized by an accumulation of illuvial clay.

Arroyo. The flat-floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in alluvium.

Aspect. The direction in which a slope faces.

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

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:

Very low	0 to 3.5
Low	3.5 to 5.0
Moderate	5.0 to 7.5
High	7.5 to 10
Very high	more than 10

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, are linear, and may or may not include cliff segments.

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.

Bajada. A broad alluvial slope extending from the base of a mountain range out into a basin and formed by coalescence of separate alluvial fans.

Basal area. The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine strata, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediment.

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography. A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout. A shallow depression from which all or most of the soil material has been removed by the wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 10 to 20 inches high and 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Breaks. The steep and very steep broken land at the border of an upland summit that is dissected by ravines.

Breast height. An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management. Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

Butte. An isolated small mountain or hill with steep or precipitous sides and a top variously flat, rounded, or pointed that may be a residual mass isolated by erosion or an exposed volcanic neck.

Cable yarding. A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds directly beneath the solum, or it is exposed at the surface by erosion.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Canyon. A long, deep, narrow, very steep sided valley with high, precipitous walls in an area of high local relief.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Channery soil material. Soil material that is, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

Chemical treatment. Control of unwanted vegetation through the use of chemicals.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Cirque. A semicircular, concave, bowllike area that has steep faces primarily resulting from glacial ice and snow abrasion.

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 depletions. Low-chroma zones having a low content of iron, manganese, and clay because of the chemical reduction of iron and manganese and the removal of iron, manganese, and clay. A type of redoximorphic depletion.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax plant community. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Cemented bodies with crude internal symmetry organized around a point, a line, or a plane. They typically take the form of concentric layers visible to the naked eye. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up concretions. If formed in place, concretions of iron oxide or manganese oxide are generally considered a type of redoximorphic concentration.

Conglomerate. A coarse grained, clastic rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system. Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the "Soil Survey Manual."

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coppice dune. A small dune of fine grained soil material stabilized around shrubs or small trees.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

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.

Cropping system. Growing crops according to a planned system of rotation and management practices.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cross-slope farming. Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Cuesta. A hill or ridge that has a gentle slope on one side and a steep slope on the other; specifically, an asymmetric, homoclinal ridge capped by resistant rock layers of slight or moderate dip.

Culmination of the mean annual increment (CMAI). The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Delta. A body of alluvium having a surface that is nearly flat and fan shaped; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Desert pavement. On a desert surface, a layer of gravel or larger fragments that was emplaced by upward movement of the underlying sediments or that remains after finer particles have been removed by running water or the wind.

Dip slope. A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Divided-slope farming. A form of field stripcropping in which crops are grown in a systematic arrangement of two strips, or bands, across the slope to reduce the hazard of water erosion. One strip is in a close-growing crop that provides protection from erosion, and the other strip is in a crop that provides less protection from erosion. This practice is used where slopes are not long enough to permit a full stripcropping pattern to be used.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained.* These classes are defined in the "Soil Survey Manual."

Drainage, surface. Runoff, or surface flow of water, from an area.

Draw. A small stream valley that generally is more open and has broader bottom land than a ravine or gulch.

Duff. A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation. A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Ephemeral stream. A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation. A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion. The wearing away of the land surface by 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 human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

Esker. A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sodium (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Excess sulfur (in tables). Excessive amount of sulfur in the soil. The sulfur causes extreme acidity if the soil is drained, and the growth of most plants is restricted.

Extrusive rock. Igneous rock derived from deep-seated molten matter (magma) emplaced on the earth's surface.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fan terrace. A relict alluvial fan, no longer a site of active deposition, incised by younger and lower alluvial surfaces.

Fast intake (in tables). The rapid movement of water into the soil.

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.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, or clay.

Firebreak. Area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flaggy soil material. Material that is, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Of or pertaining to rivers; produced by river action, as a fluvial plain.

Foothill. A steeply sloping upland that has relief of as much as 1,000 feet (300 meters) and fringes a mountain range or high-plateau escarpment.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai. Commonly, a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of clayey soils that shrink and swell considerably with changes in moisture content.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water. Water filling all the unblocked pores of the material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

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.

Head out. To form a flower head.

High-residue crops. Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the "Soil Survey Manual." The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon 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.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

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 overlying soil material.

The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

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

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions. Low-chroma zones having a low content of iron and manganese oxide because of chemical reduction and removal, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic depletion.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

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.

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.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

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.

Karst (topography). The relief of an area underlain by limestone that dissolves in differing degrees, thus forming numerous depressions or small basins.

Knoll. A small, low, rounded hill rising above adjacent landforms.

Lacustrine deposit. Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low-residue crops. Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Low strength. The soil is not strong enough to support loads.

Marl. An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal amounts.

Masses. Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.

Mechanical treatment. Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat topped and commonly isolated upland mass characterized by summit widths that are more than the heights of bounding erosional scarps.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

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. 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).

Mountain. A natural elevation of the land surface, rising more than 1,000 feet above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can occur as a single, isolated mass or in a group forming a chain or range.

Muck. Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mudstone. Sedimentary rock formed by induration of silt and clay in approximately equal amounts.

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Natric horizon. A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil. A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules. Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Observed rooting depth. Depth to which roots have been observed to penetrate.

Open sapce. A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment. A thin layer of alluvial material that mantles an erosion surface and has been transported to its present position from higher lying areas of the erosion surface.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affects the specified use.

Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as "saturated hydraulic conductivity," which is defined in the "Soil Survey Manual." In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as "permeability." Terms describing permeability, measured in inches per hour, are as follows:

Extremely slow	0.0 to 0.01 inch
Very slow	0.01 to 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

Playa. The generally dry and nearly level lake plain that occupies the lowest parts of closed depressional areas, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid or very rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Potential native plant community. The plant community on a given site that will be established if present environmental conditions continue to prevail and the site if properly managed. See Climax plant community.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning. Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

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

Proper grazing use. Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure 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 degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Red beds. Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

Redoximorphic concentrations. Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

Redoximorphic depletions. Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

Redoximorphic features. Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

Reduced matrix. A soil matrix that has low chroma in situ because of chemically reduced iron (Fe II). The chemical reduction results from nearly continuous wetness. The matrix undergoes a change in hue or chroma within 30 minutes after exposure to air as the iron is oxidized (Fe III). A type of redoximorphic feature.

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

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

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill generally is a few inches deep and not wide enough to be an obstacle to farm machinery.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Salinity. The degree to which a soil is affected by soluble salt.

Nonsaline	0 to 2 dS/m (mmhos/cm)
Very slight or very slightly saline	2 to 4 dS/m (mmhos/cm)
Slight or slightly saline	4 to 8 dS/m (mmhos/cm)
Moderate or moderately saline	8 to16 dS/m (mmhos/cm)
Strong or strongly saline	more than 16 dS/m (mmhos/cm)

Salty water (in tables). Water that is too salty for consumption by livestock.

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. **Sandstone.** Sedimentary rock containing dominantly sand-sized particles. **Sapric soil material (muck).** The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saprolite. Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Saturation. Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification. The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Second bottom. The first terrace above the normal flood plain (or first bottom) of a river.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell (in tables). 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.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

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.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface high in soluble salts and sodium. The surface is impermeable to moisture and subject to ponding for short periods.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey, the following slope classes are recognized:

Nearly level	0 to 3 percent
Gently sloping or undulating	3 to 7 percent
Strongly sloping or rolling	7 to 15 percent
Moderately steep or hilly	15 to 25 percent
Steep	25 to 55 percent
Very steep	55 percent or higher

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Sloughed till. Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodic (alkali) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to $Ca^{++} + Mg^{++}$. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It 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, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of rock fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. 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."

Surface soil. The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus. Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

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 and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material that is too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Too arid (in tables). The soil is dry most of the time, and vegetation is difficult to establish.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Toxicity (in tables). Excessive amount of toxic substances, such as sodium or sulfur, that severely hinder establishment of vegetation or severely restrict plant growth.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland. Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The uprooting and tipping over of trees by the wind.