United States Department of Agriculture

Natural Resources Conservation Service

United States Department of the Interior

National Park Service

Soil Survey of Wupatki National Monument, Arizona

How To Use This Soil Survey

General Soil Map

The general soil map, which is a color map, 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.

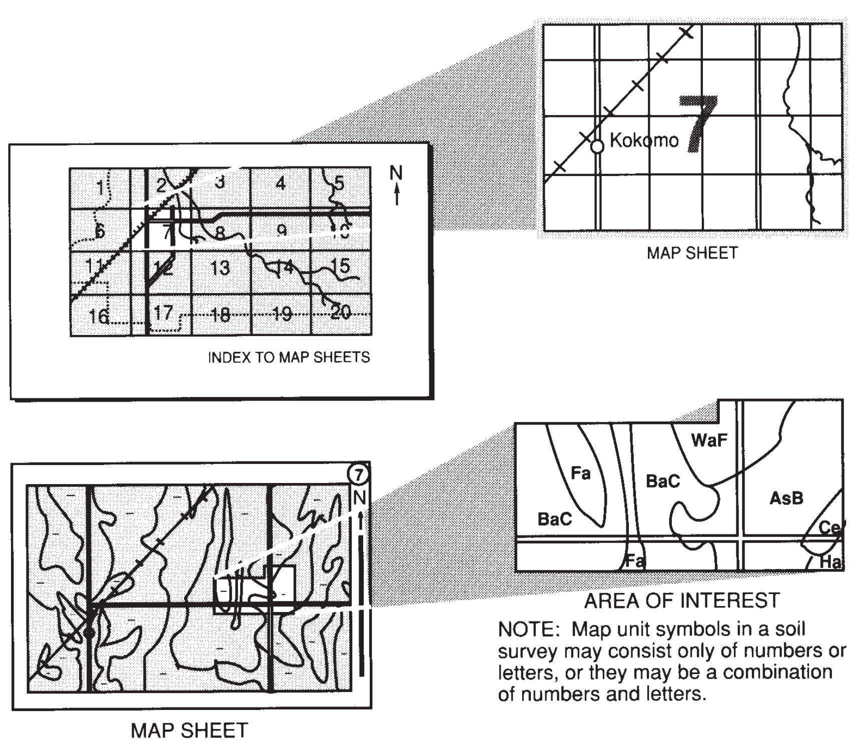
Detailed Soil Maps

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

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

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

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.



National Cooperative Soil Survey

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 has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 2012. Soil names and descriptions were approved in February 2013. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 2013. This survey was made cooperatively by the Natural Resources Conservation Service and the National Park Service.

The 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, the maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Literature Citation

The correct citation for this survey is as follows:

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Cover Caption

Wupatki Basin and Doney Cliffs as seen from the Visitor Center at Wupatki National Monument. Shallow and moderately deep soils in the foreground are in map unit 112 (Moenkopie-Typic Haplocambids complex, 1 to 12 percent slopes). The moderately deep Typic Haplocambids generally occur in lower-lying areas where tephra accumulates and is protected from erosion. Beyond the rocks in the near foreground is an area of map unit 116 (Rock outcrop-Typic Torriorthents-Heiser association, 3 to 40 percent slopes) (not seen in photo). This is the canyon-forming map unit that covers much of Deadman Wash. The long escarpment in the background is Doney Cliffs, in an area of map unit 108 (Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes).

Additional information about the Nation's natural resources is available online from the Natural Resources Conservation Service at http://www.nrcs.usda.gov/.

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Foreword

This soil survey was developed in conjunction with the National Park Service's Soil Inventory and Monitoring Program and is intended to serve as the official source document for soils occurring within Wupatki National Monument, Arizona.

Soil surveys contain information that affects land use planning in survey areas. They include predictions of soil behavior for selected land uses. The surveys highlight soil limitations, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

Soil surveys are designed for many different users. Farmers, ranchers, foresters, and agronomists can use the surveys to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the surveys 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 surveys 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 on 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 seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. The location of each map unit is shown on the detailed soil maps. Each soil in the survey area is described, and information on specific uses is given. 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.

Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or Cooperative Extension Service or at the National Park Service's Natural Resources Program Center.

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Soil Survey of Wupatki National Monument, Arizona

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United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with United States Department of the Interior, National Park Service

WUPATKI NATIONAL MONUMENT lies within the State of Arizona, approximately 40 kilometers (25 miles) north-northeast of Flagstaff (fig. 1). It comprises approximately 35,422 acres. It was established by President Calvin Coolidge on December 9, 1924 to protect the prehistoric ruins and associated lands from further damage (figs. 2 and 3). The monument was listed on the National Register of Historic Places on October 15, 1966.

Sometime in the 12th century, the Sinagua built the cliff dwellings that survive to this day, although many of the artifacts were removed after the railroad was completed in the 1880s. The structures at the Wupatki Pueblo alone housed about 100 people. Later, around 1225 A.D., the site was permanently abandoned.

The four major ruins available to visitors are Citadel Ruin, Lomaki Ruin, Wukoki Ruin, and Wupatki Ruin. Citadel and Lomaki Ruins sit above the Visitor Center on the edges of Antelope Prairie and East Mesa (see Citadel Ruin Block included with this document). Wukoki Ruin sits below the Visitor Center in the Wupatki Basin, along the edge of Heiser Wash (see Wukoki Ruin Block). Wupatki Ruin sits adjacent to the Visitor Center at the base of Woodhouse Mesa, along Deadman Wash (see Wupatki Ruin Block). A substantial portion of the south boundary of the monument borders Coconino National Forest. The north and west boundaries separate the park from private land. To the east of the monument is the Navajo Nation.

The monument is accessible by vehicle. Highway 89 runs near the western boundary. The west entrance to the park from Highway 89 is approximately 4 kilometers (2.5 miles) north of the park's south boundary. The south boundary is visible behind the Antelope Hills/Sinagua Trading Post. The west entrance is 2 kilometers (1.25 miles) south of Hank's Trading Post. The north boundary is 925 meters north of the west entrance and 1,050 meters south of Hank's Trading Post. The park is also accessible from the south on the road that runs through Sunset Crater Volcano National Monument. The southern road approaches the park in the Wupatki Basin area, near the Visitor Center.

Figure 1.—Location of Wupatki National Monument in Arizona.

Figure 2.—The ruin at Middle Mesa, as seen from the trail to Citadel Ruin. The stone structures in Wupatki National Monument belonged to the Sinagua, the Cohonina, and the Kayenta Anasazi. These people preferred to construct their dwellings on hills. These sites provided better visibility and were not subject to flooding and ponding. Map unit 104 (Flaco-Lava flows complex) is associated with these hills.

Figure 3.—This Wupatki lizard is sunning and watching the arrival of new guests to the Visitor Center at Wupatki National Monument.

Descriptions, names, and delineations of soils in the survey may not fully agree with some of the soil maps for adjacent soil survey areas. The differences are the result of mapping intensity, the availability of more recent resources of technology for mapping, modifications in series concepts, or the extent of soils within the survey.

General Nature of the Park

This section discusses the major land resource areas and the physiography and climate of Wupatki National Monument.

Major Land Resource Areas

Major land resource areas (MLRAs) are large geographic areas identified by similar temperature, precipitation, physiography, and management (fig. 4). Wupatki National Monument has one MLRA, namely MLRA 35—Colorado Plateau. Within MLRA 35 are smaller land resource units (LRUs) which indicate precipitation, temperature, timing of moisture, and elevation as they pertain to management of soils and vegetation.

MLRA 35 is in the Colorado Plateaus Province of the Intermotane Plateaus. The area is defined by a large structurally uplifted plateau that has been cut down by rivers. This large plateau stretches from northern Arizona into southern Utah and western New Mexico. It includes the entire Navajo Nation, Grand Canyon National Park, Canyon Lands National Park, and the Grand Staircase Escalante National Monument. The dominant geology is shale, sandstone, limestone, and volcanic rocks.

Annual precipitation ranges from less than 5 to 30 inches; most of the park receives 6 to 10 inches annually. Most precipitation is from intense thunderstorms during the monsoon season, July through September; May and June are the driest months of

MLRA	Elevation (feet)	Average annual precipitation (inches)	Soil temperature regime	Soil moisture regime
35.1	5,100-6,000	10-14	mesic	ustic aridic
35.2	3,500-5,500	6-10	mesic	typic aridic

Figure 4.—Summary of major land resource areas in Wupatki National Monument.

the year. About three-fourths of the survey area is rangeland used for grazing, and less than 1 percent is irrigated cropland. In Wupatki National Monument, MLRA 35 consists of two parts: MLRA 35.1, which is dominated by mixed grass plains and has 10 to 14 inches of precipitation annually, and MLRA 35.2, which is dominated by shrub grasslands and has 6 to 10 inches of precipitation annually.

Physiography

Wupatki National Monument lies in the northeast corner of a large portion of the San Francisco Volcanic Field. The volcanic field remains active over a hot spot. Recent activity has occurred on the east end of the park to the north and to the south. Doney Cliffs visibly separate the upper western portion (Antelope Prairie) from the lower eastern portion (Wupatki Basin). Doney Cliffs and Doney Mountain are a result of normal faulting (see Doney Mountain Block).

Climate

Table 1 gives data on temperature and precipitation for the survey area as recorded at Wupatki National Monument, Arizona, in the period 1940 to 2013. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on the length of the growing season.

In winter, the average temperature is 4.8 degrees C and the average daily minimum temperature is -2.0 degrees C. The lowest temperature on record, which occurred at Wupatki National Monument on December 21, 1968, was -28 degrees C. In summer, the average temperature is 25.0 degrees C and the average daily maximum temperature is 33.1 degrees C. The highest temperature, which occurred at Wupatki National Monument on July 9, 2002, was 43 degrees C.

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 (10 degrees C). 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 average annual total precipitation is 20.27 centimeters. Of this, 12.55 centimeters, or about 62 percent, usually falls in April through October. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 5.36 centimeters, recorded at Wupatki National Monument on July 29, 1945. Monsoonal rain patterns typically begin in July and last into September, and most thunderstorms occur between July and September. Brief heavy rains and thunderstorms may occur on a nearly daily basis.

The average seasonal snowfall is 16.3 centimeters. The greatest snow depth at any one time during the period of record was 81 centimeters, recorded on December 16, 1967. The heaviest 1-day snowfall on record was 31.8 centimeters, recorded on December 14, 1967.

How This Survey Was Made

This survey was made in conjunction with the National Park Service's Soil Inventory and Monitoring Program 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. A scoping meeting was held in 2010 with park staff to identify soil resource and information needs. Of particular importance is the relationship between soil type and plant communities to climatic regimes and landforms. Also of interest is possibility of past and present water tables within dry washes found in the basin.

During the soil survey, relationships between ecological site and soil components were observed and noted and soil-site correlation concepts were established to aid in designing map units. Soil and plant specialists described and tested concepts during mapping and collected field documentation at numerous points across the landscape.

Soil scientists collect field soil information, including location and description of soils and miscellaneous areas. Soil scientists observe the steepness, length, and shape of slopes; soil textures and structures; the general pattern of drainage; kinds of vegetation; and kinds of bedrock. Scientists excavate small pits to analyze soil profiles, the vertical sequence of natural layers, or visible horizons, that have formed due to soil-forming processes. Calculations include permeability, runoff, soil water-holding capacity, and susceptibility to wind erosion as well as the suitability, limitations, and management of soils for specified uses.

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. Several tools can be used to expedite mapping without loss of accuracy. Use of remotely sensed data greatly improves the soil scientist's ability to detect changes in landforms and geologic parent material. Satellite imagery has also been valuable in soil mapping. Manipulation of spectral bands on this imagery can enhance and elucidate certain conditions, such as the presence of basic minerals or vegetation types.

Soil scientists record the nature of soil profiles, noting soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features. After describing the soils in the survey area and determining their properties, soil scientists assign taxonomic classes (units). Each taxonomic class has a set of soil characteristics with specific limits. Soil taxonomy considers soil properties and soil horizons within the profile.

Describing Soil Profiles

Soil profiles consist commonly of five major horizons, designated as O, A, E, B, and C horizons. O horizons consist of decomposing organic materials. The A horizons are mineral horizons that have an organic matter content that is higher than that of underlying horizons but less than that of overlying O horizons. The A horizon may be the surface layer if there is no O horizon. The E horizon is the zone of maximum leaching of materials. E horizons commonly are found in wetter climates or wetter soil conditions on certain landscapes and may overlie a B horizon (a zone of accumulation). C horizons are in the bottom part of a soil profile and are most related to the parent material.

The B horizon lies directly below the A horizon. In some soils it may have not developed, while in other soils it may be very developed. This horizon varies in color, and color plays an important part in distinguishing B horizons. The B horizon is the horizon of maximum accumulation of dissolved or suspended materials, for example, iron, clay, or calcium carbonate. It can be an altered horizon whose structure is distinct from that of the A horizon but show little evidence of clay translocation or accumulation. An example of a B horizon in which calcium carbonate has accumulated and concentrated is a Bk horizon. Flaco, Nalakihu, and Pocum soils have Bk horizons. A B horizon that contains a significant amount of clay accumulation is called a Bt horizon. Flaco soils have this horizon. Subsurface horizons that show little evidence of accumulation, but have been altered in some way by the soil-forming processes, are Bw horizons. Bighawk, Chedeski, and Gish soils and Typic Haplocambids have these horizons. The C horizon is relatively unchanged by the soil-forming processes. Heiser, Ives, Miburn, and Trachute soils have C horizons. An R layer underlies some of the soils in the survey area and is generally limestone, basalt, or calcareous sandstone bedrock. Meriwhitica, Moenkopie, Peshlaki, and Shinume soils have R layers.

After describing the soils in the survey area and determining their properties, 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. Classes are used as a basis for comparison to classify soils systematically (see table 30). 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.

Soil samples are collected for laboratory analyses. Soil scientists interpret data from these analyses as well as field observations to describe and forecast soil behavior under various types of use and management called soil interpretations. Interpretations may be modified to fit local conditions, and new interpretations are developed to meet local needs. Additional sources of information include academic research and investigation, production records, and experience of field specialists.

Soil behavior estimations are based not only on properties within the soil, but also on external variables such as climate and biological activity. Soil conditions may be estimated over periods of time, but not necessarily for a point in time without continuous direct observations. For example, soil scientists can predict with some degree of accuracy that a soil will have a high water table to certain depths in most years, but they cannot predict water table height for a specific date.

General Soil Map Units

The general soil map in 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.

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 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 section provides descriptions of the general soil map units in the survey area. The map units have been divided into two groups: 1) soils within the 6- to 10-inch (15- to 25-cm) precipitation zone, and 2) soils within the 10- to 14-inch (25- to 35-cm) precipitation zone. The soils in the first group make up 48 percent of the survey area, and those in the second group make up 52 percent.

Soils within the 6- to 10-inch (15- to 25-cm) precipitation zone

1—Nalakihu consociation

Moderately deep to very deep, nearly level to gently sloping, well drained soils that formed from older lava flows

Map Unit Setting

Ecological site association(s): Loamy Upland 6-10” p.z.
Dominant vegetation: Galleta, alkali sacaton, and rubber rabbitbrush
Landscape: Colorado Plateau
Landform setting: Lava plains
Elevation: 4,662 to 4,812 feet (1,421 to 1,467 meters)
Land resource unit: 35-2 Colorado Plateau-Shrub - Grasslands
Slope range: 0 to 4 percent

Map Unit Composition

Extent of the map unit in the survey area: 0.6 percent
Extent of the components in the map unit:
Nalakihu and similar soils: 85 percent
Minor components: 15 percent; Torriorthents on alluvium and Miburn soils on dunes of tephra

Major Component Description

Nalakihu
Depth class: Moderately deep
Drainage class: Well drained
Geomorphic position: Lava plains
Parent material: Basalt
Slope: 0 to 4 percent
Ecological site ID: R035XB210AZ

2—Moenkopie-Shinume-Rock outcrop association

Very shallow and shallow, gently sloping to moderately steep, well drained to excessively drained soils that formed from sedimentary residuum

Map Unit Setting

Ecological site association(s): Sandstone/Shale Upland 6-10” p.z.
Dominant vegetation: Torrey’s jointfir, galleta, and fourwing saltbush
Landscape: Colorado Plateau
Landform setting: Structural benches and cuestas
Elevation: 4,281 to 4,951 feet (1,305 to 1,509 meters)
Land resource unit: 35-2 Colorado Plateau-Shrub - Grasslands
Slope range: 2 to 23 percent

Map Unit Composition

Extent of the map unit in the survey area: 29.0 percent
Extent of the components in the map unit:
- Moenkopie and similar soils: 49 percent
- Shinume and similar soils: 24 percent
- Rock outcrop: 14 percent
- Minor components: 13 percent; Sandy, Typic Torriorthents on dip slopes of cuestas, Lithic Torripsamments on structural benches, and Badland on cuestas

Major Component Descriptions

Moenkopie
Depth class: Very shallow
Drainage class: Well drained
Geomorphic position: Structural benches
Parent material: Sedimentary residuum
Slope: 1 to 14 percent
Ecological site ID: R035XB215AZ

Shinume
Depth class: Shallow
Drainage class: Well drained
Geomorphic position: Scarp slopes of cuestas
Parent material: Sedimentary residuum
Slope: 2 to 30 percent
Ecological site ID: R035XB215AZ

Rock outcrop

Parent material: Sandstone

3—Rock outcrop-Torriorthents-Heiser association

Shallow to very deep, gently sloping to steep, well drained to excessively drained soils that formed from tephra over alluvium or from alluvium

Map Unit Setting

Ecological site association(s): Loamy Upland 6-10” p.z., Sandstone/Shale Upland 6-10” p.z., and Basalt Upland 6-10” p.z.
Dominant vegetation: Galleta, fourwing saltbush, and Apache plume
Landscape: Colorado Plateau
Landform setting: Terrace deposits, canyons, and washes
Elevation: 4,284 to 4,960 feet (1,306 to 1,512 meters)
Land resource unit: 35-2 Colorado Plateau-Shrub - Grasslands
Slope range: 1 to 40 percent

Map Unit Composition

Extent of the map unit in the survey area: 9.7 percent
Extent of the components in the map unit:
- Rock outcrop: 24 percent
- Torriorthents and similar soils: 23 percent
- Heiser and similar soils: 17 percent
- Minor components: 36 percent; Ives soils on washes, Trachute soils on terraces, Moenkopie soils on structural benches, and Shinume soils on canyon cliff faces

Major Component Descriptions

Rock outcrop
Parent material: Sandstone

Torriorthents
Depth class: Very shallow and shallow
Drainage class: Well drained
Geomorphic position: Escarpments
Parent material: Residuum
Slope: 3 to 40 percent
Ecological site ID: R035XB210AZ

Heiser
Depth class: Very deep
Drainage class: Excessively drained
Geomorphic position: Climbing dune deposits
Parent material: Tephra
Slope: 3 to 40 percent
Ecological site ID: R035XB210AZ

4—Miburn-Cambidic Haplodurids complex

Shallow to very deep, gently sloping, well drained soils that formed from relict alluvium or from tephra deposits over relict alluvium

Map Unit Setting

Ecological site association(s): Loamy Upland 6-10” p.z., Sandstone/Shale Upland 6-10” p.z., and Basalt Upland 6-10” p.z.
Dominant vegetation: Galleta, fourwing saltbush, and Apache plume

Landscape: Colorado Plateau
Landform setting: Terrace deposits, canyons, and washes
Elevation: 4,284 to 4,960 feet (1,306 to 1,512 meters)
Land resource unit: 35-2 Colorado Plateau-Shrub - Grasslands
Slope range: 1 to 40 percent

Map Unit Composition

Extent of the map unit in the survey area: 3.5 percent
Extent of the components in the map unit:
Miburn and similar soils: 45 percent
Cambidic Haplodurids and similar soils: 40 percent
Minor components: 15 percent; Typic Haplocambids on eolian tephra over residuum and Heiser soils on dunes

Major Component Descriptions

Miburn
Depth class: Very deep
Drainage class: Excessively drained
Geomorphic position: Dunes
Parent material: Tephra over alluvium or residuum
Slope: 1 to 8 percent
Ecological site ID: R035XB210AZ

Cambidic Haplodurids
Depth class: Shallow
Drainage class: Well drained
Geomorphic position: Terrace deposits
Parent material: Mixed alluvium
Slope: 1 to 8 percent
Ecological site ID: R035XB210AZ

5—Moenkopie-Typic Haplocambids-Miburn association

Shallow to very deep, gently sloping to moderately steep, well drained soils that formed from tephra deposits over sedimentary residuum or from tephra deposits over dune deposits

Map Unit Setting

Ecological site association(s): Loamy Upland 6-10” p.z. and Sandstone/Shale Upland 6-10” p.z
Dominant vegetation: Torrey’s jointfir, fourwing saltbush, and buckwheat
Landscape: Colorado Plateau
Landform setting: Structural benches, dunes, and escarpments
Elevation: 4,393 to 5,239 feet (1,339 to 1,597 meters)
Land resource unit: 35-2 Colorado Plateau-Shrub - Grasslands
Slope range: 1 to 45 percent

Map Unit Composition

Extent of the map unit in the survey area: 10.2 percent
Extent of the components in the map unit:
Moenkopie and similar soils: 36 percent
Typic Haplocambids and similar soils: 33 percent
Miburn and similar soils: 11 percent

Minor components: 20 percent; Lithic Torripsamments on structural benches, Heiser on dunes of tephra, and Lava flows

Major Component Descriptions

Moenkopie
Depth class: Very shallow
Drainage class: Well drained
Geomorphic position: Structural benches
Parent material: Sedimentary residuum
Slope: 1 to 6 percent
Ecological site ID: R035XB215AZ

Typic Haplocambids
Depth class: Moderately deep
Drainage class: Well drained
Geomorphic position: Structural benches
Parent material: Sedimentary residuum
Slope: 1 to 6 percent
Ecological site ID: R035XB210AZ

Miburn
Depth class: Moderately deep
Drainage class: Excessively drained
Geomorphic position: Structural benches
Parent material: Tephra over eolian deposits or alluvium
Slope: 1 to 45 percent
Ecological site ID: R035XB210AZ

Soils within the 10- to 14-inch (25- to 35-cm) precipitation zone

6—Flaco-Lava flows association

Moderately deep, nearly level to moderately steep, well drained soils that formed from basaltic lava or from tephra deposits over basaltic lava

Map Unit Setting

Ecological site association(s): Volcanic Upland 10-14” p.z.
Dominant vegetation: Oneseed juniper, galleta, and black grama
Landscape: Colorado Plateau
Landform setting: Lava plains
Elevation: 4,977 to 5,712 feet (1,517 to 1,741 meters)
Land resource unit: 35-1 Colorado Plateau-Mixed Grass Plains
Slope range: 0 to 18 percent

Map Unit Composition

Extent of the map unit in the survey area: 13.6 percent
Extent of the components in the map unit:
Flaco and similar soils: 79 percent
Lava flows: 8 percent
Minor components: 13 percent; Meriwhitica soils on structural benches and Bighawk soils on alluvial fans and terraces

Major Component Descriptions

Flaco
Depth class: Moderately deep
Drainage class: Well drained
Geomorphic position: Lava plains
Parent material: Basalt
Slope: 0 to 18 percent
Ecological site ID: R035XA108AZ

Lava flows
Parent material: Basalt

7—Peshlaki-Chedeski-Rock outcrop association

Very shallow and shallow, nearly level to moderately steep, well drained soils that formed from sedimentary residuum or from tephra deposits over sedimentary residuum

Map Unit Setting

Ecological site association(s): Volcanic Upland 10-14” p.z.
Dominant vegetation: Oneseed juniper, galleta, and black grama
Landscape: Colorado Plateau
Landform setting: Structural benches and cliffs
Elevation: 4,504 to 5,528 feet (1,373 to 1,685 meters)
Land resource unit: 35-1 Colorado Plateau-Mixed Grass Plains
Slope range: 0 to 11 percent

Map Unit Composition

Extent of the map unit in the survey area: 31.9 percent
Extent of the components in the map unit:
- Peshlaki and similar soils: 59 percent
- Chedeski and similar soils: 16 percent
- Rock outcrop: 10 percent
- Minor components: 15 percent; Meriwhitica soils on cliff faces and Ustolls on tephra cover within dips of flat plains

Major Component Descriptions

Peshlaki
Depth class: Very shallow
Drainage class: Well drained
Geomorphic position: Structural benches
Parent material: Tephra over sedimentary rock or residuum
Slope: 1 to 11 percent
Ecological site ID: R035XA108AZ

Chedeski
Depth class: Shallow
Drainage class: Well drained
Geomorphic position: Structural benches
Parent material: Tephra over residuum
Slope: 0 to 6 percent
Ecological site ID: R035XA108AZ

Rock outcrop
Parent material: Limestone and sandstone

8—Bighawk-Flaco-Tsosie association

Moderately deep to very deep, level to gently sloping, well drained soils that formed from alluvium and lacustrine deposits

Map Unit Setting

Ecological site association(s): Loamy Upland 10-14" p.z. and Volcanic Upland 10-14" p.z.
Dominant vegetation: Galleta, needle and thread, and black grama
Landscape: Colorado Plateau
Landform setting: Terrace deposits, alluvial fans, valley fill deposits, and relict lake beds
Elevation: 5,265 to 5,721 feet (1,605 to 1,744 meters)
Land resource unit: 35-1 Colorado Plateau-Mixed Grass Plains
Slope range: 0 to 18 percent

Map Unit Composition

Extent of the map unit in the survey area: 7.6 percent
Extent of the components in the map unit:
- Bighawk and similar soils: 44 percent
- Flaco and similar soils: 25 percent
- Tsosie and similar soils: 12 percent
- Minor components: 19 percent; Pocum soils on relict terraces, Gish soils on lacustrine deposits, and Ustolls on tephra cover within dips of flat plains

Major Component Descriptions

Bighawk
Depth class: Very deep
Drainage class: Well drained
Geomorphic position: Alluvial fans
Parent material: Tephra
Slope: 1 to 5 percent
Ecological site ID: R035XA108AZ

Flaco
Depth class: Moderately deep
Drainage class: Well drained
Geomorphic position: Lava plains and relict terraces
Parent material: Mixed alluvium
Slope: 1 to 3 percent
Ecological site ID: R035XA113AZ

Tsosie
Depth class: Very deep
Drainage class: Well drained
Geomorphic position: Valley fill deposits
Parent material: Mixed alluvium
Slope: 1 to 5 percent
Ecological site ID: R035XA113AZ

9—Bighawk family-Vitrandic Torriorthents association

Very deep, gently sloping to steep, well drained soils that formed from tephra deposits

Map Unit Setting

Ecological site association(s): Volcanic Upland 10-14” p.z and Cinder Hills 10-14” p.z.
Dominant vegetation: Apache plume, black grama, and oneseed juniper
Landscape: Colorado Plateau
Landform setting: Cinder cones and ash fields
Elevation: 4,757 to 5,591 feet (1,450 to 1,704 meters)
Land resource unit: 35-1 Colorado Plateau-Mixed Grass Plains
Slope range: 2 to 63 percent

Map Unit Composition

Extent of the map unit in the survey area: 1.0 percent
Extent of the components in the map unit:
  Bighawk family and similar soils: 62 percent
  Vitrandic Torriorthents and similar soils: 28 percent
  Minor components: 10 percent; Peshlaki soils on structural benches

Major Component Descriptions

Bighawk family
Depth class: Very deep
Drainage class: Well drained
Geomorphic position: Ash fields
Parent material: Tephra over mixed alluvium
Slope: 2 to 11 percent
Ecological site ID: R035XA108AZ

Vitrandic Torriorthents
Depth class: Moderately deep
Drainage class: Well drained
Geomorphic position: Relict terraces
Parent material: Mixed alluvium
Slope: 10 to 63 percent
Ecological site ID: R035XA102AZ

Detailed Soil Map Units

The map units delineated on the detailed soil maps in this survey represent the soils or miscellaneous areas in the park. 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.

A map unit delineation on a soil 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. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils 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 minor components that belong to taxonomic classes other than those of the major soils.

Most minor 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, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. 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 contrasting components are mentioned in the map unit descriptions. A few areas of minor components 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 minor components 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 maps provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, 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*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. The soils of a given 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, Flaco extremely gravelly coarse sand, 1 to 3 percent slopes, is a phase of the Flaco series. The map unit descriptions include a full pedon description for each major soil component.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes. 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 map. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Ives-Riverwash complex, 1 to 5 percent slopes, rarely flooded, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Rock outcrop-Typic Torriorthents-Heiser association, 3 to 40 percent slopes, is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. The Rock outcrop part of Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes, is an example.

Table 4 lists each map unit in the park, its major components, and the percentage of each major component in the unit. Table 5 gives the acreage, number of hectares, and proportionate extent of each map unit. Table 6 identifies the major map unit components in the survey area, the map unit(s) in which each occurs, the local phase and component kind, and correlated ecological sites. Other 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.

100—Bighawk gravelly sandy loam, 1 to 5 percent slopes

Map Unit Setting

Landform(s): Alluvial fans (fig. 5)
Elevation: 5,370 to 5,720 feet (1,638 to 1,744 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Bighawk and similar soils: 100 percent

Description of the Bighawk Soil

Taxonomic classification: Ashy-skeletal, glassy, mesic Vitrandic Haplocambids
Taxon kind: Series
Geomorphic position: Treads of fans
Parent material: Alluvium derived from volcanic rock
Elevation: 5,370 to 5,720 feet (1,638 to 1,744 meters)
Slope: 1 to 5 percent
Drainage class: Somewhat excessively drained
K_{sat} *in solum:* 1.98 to 5.95 inches per hour (14.00 to 42.00 micrometers per second)
Available water capacity (total inches): 3.7 (low)
Shrink-swell potential: About 0.8 LEP (low)

Figure 5.—An area of Bighawk gravelly sandy loam, 1 to 5 percent slopes

Flooding hazard: None
Ponding hazard: None
Runoff class: Very low
Hydrologic group: A
Ecological site name: Volcanic Upland 10-14" p.z.
Ecological site number: R035XA108AZ
Present vegetation: Galleta, black grama, needle and thread, rubber rabbitbrush, Russian thistle, Rocky Mountain zinnia, forbs, and annuals
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 6)

Canopy plant cover	58
Woody debris	0
Herbaceous litter	20
Bare soil	0
Rock fragments (cinders)	50

Typical Pedon (figs. 7 though 10)

Location by Universal Transverse Mercator System: Zone 12N, 3937208 Northing, 453315 Easting

A—0 to 2 inches (0 to 5 centimeters); brown (10YR 5/3) gravelly sandy loam, brown (10YR 4/3) moist; 12 percent clay; weak fine granular structure; soft, very friable, nonsticky, nonplastic; many interstitial pores; 30 percent cinders; strongly effervescent, 8 percent calcium carbonate equivalent; moderately alkaline, pH 8.0; clear smooth boundary.

Figure 6.—Surface of Bighawk gravelly sandy loam.

Bk1—2 to 12 inches (5 to 30 centimeters); brown (10YR 5/3) very gravelly sandy loam, dark grayish brown (10YR 4/2) moist; 13 percent clay; moderate medium granular structure parting to weak thin platy; soft, very friable, nonsticky, nonplastic; many very fine and fine roots throughout; many carbonate coats around rock fragments and finely disseminated carbonate throughout; 40 percent cinders; violently effervescent, 10 percent calcium carbonate equivalent; moderately alkaline, pH 8.0; gradual smooth boundary.

Bk2—12 to 19 inches (30 to 47 centimeters); brown (10YR 5/3) very stony sandy loam, dark grayish brown (10YR 4/2) moist; 14 percent clay; weak fine granular and fine angular blocky structure; soft, very friable, slightly sticky, nonplastic; many very fine and common fine roots throughout; many carbonate coats around rock fragments and finely disseminated carbonate throughout; 15 percent stones and 20 percent cinders; violently effervescent, 12 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; gradual smooth boundary.

Bk3—19 to 24 inches (47 to 60 centimeters); brown (10YR 5/3) very gravelly sandy loam, dark grayish brown (10YR 4/2) moist; 15 percent clay; massive; soft, very friable, slightly sticky, nonplastic; common very fine roots throughout; many carbonate coats around rock fragments and finely disseminated carbonate throughout; 40 percent cinders; violently effervescent, 12 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; gradual smooth boundary.

Bk4—24 to 60 inches (60 to 152 centimeters); brown (10YR 5/3) extremely gravelly sandy loam, dark grayish brown (10YR 4/2) moist; 12 percent clay; massive; loose, nonsticky, nonplastic; many carbonate coats around rock fragments and finely disseminated carbonate throughout; 60 percent cinders; violently effervescent, 13 percent calcium carbonate equivalent; strongly alkaline, pH 8.6.

Note: Table 31 shows lab data for this pedon.

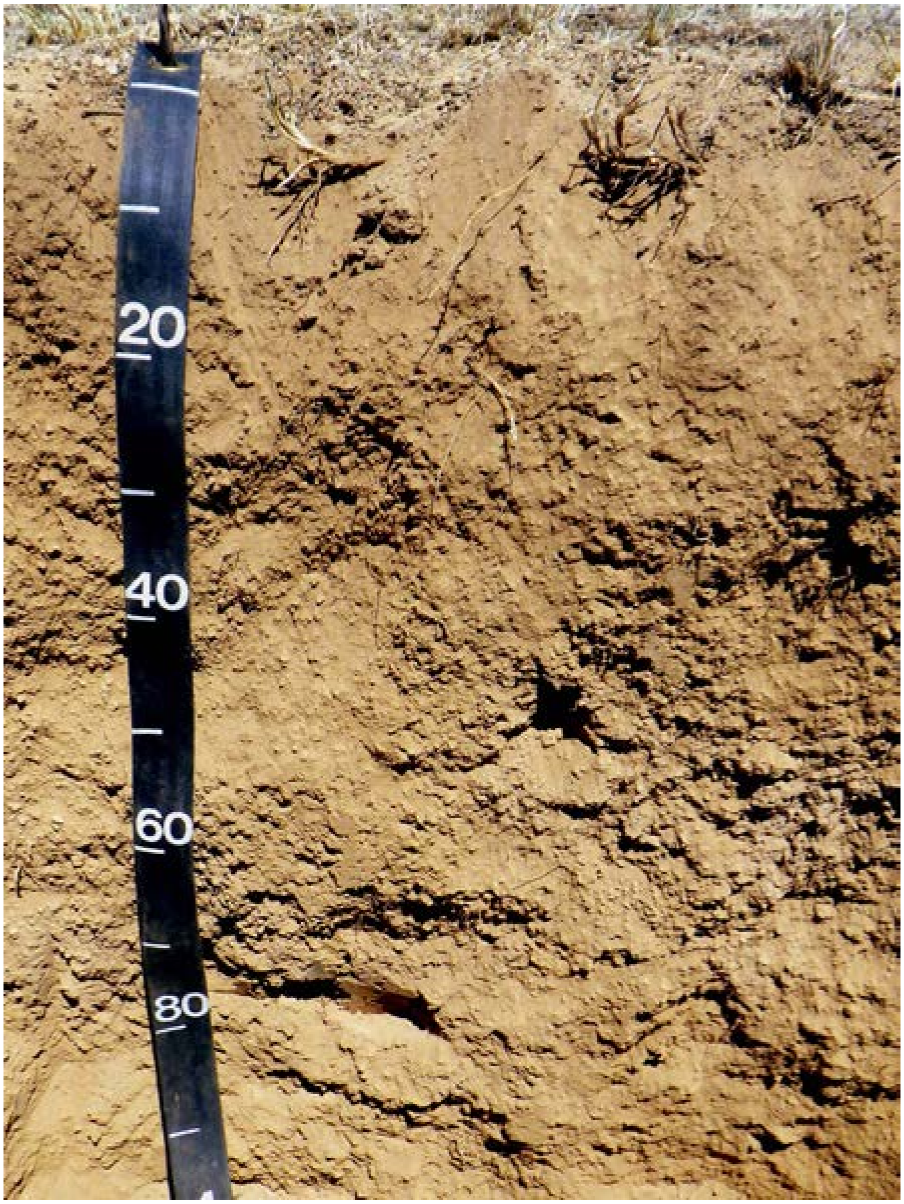


Figure 7.—Profile of Bighawk soil. Scale is in centimeters.

Range in Characteristics

Rock fragment content of the control section: 35 to 55 percent cinders
Clay content of particle-size control section: 12 to 18 percent
Volcanic glass content: 30 to 40 percent
Cambic horizon: The zone from 2 to 19 inches (5 to 47 centimeters) (Bk1 and Bk2 horizons)

A horizon:
Hue—7.5YR or 10YR
Value—3 to 5 dry; 2.5 or 4 moist
Chroma—1 to 3, dry or moist
Texture—sandy loam
Clay content—8 to 14 percent

Figure 8.—Box sample of Bighawk typical pedon.

Calcium carbonate equivalent—5 to 10 percent
Rock fragments—20 to 60 percent cinders
Reaction—slightly alkaline or moderately alkaline

Bk horizons:
Hue—7.5YR or 10YR
Value—4 to 7 dry; 4 to 6 moist
Chroma—2 to 4, dry or moist
Texture—sandy loam, fine sandy loam, or loam
Clay content—10 to 18 percent
Calcium carbonate equivalent—5 to 15 percent
Rock fragments—35 to 60 percent cinders
Reaction—moderately alkaline or strongly alkaline

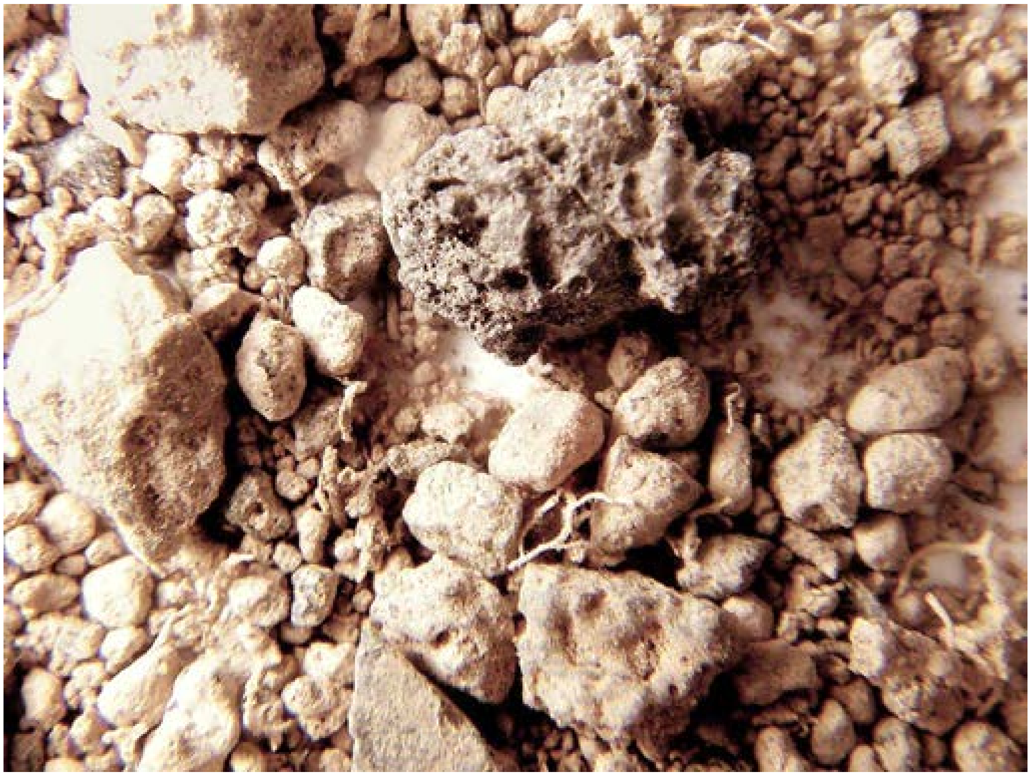


Figure 9.—Surface sand fraction from Bighawk typical pedon.

Figure 10.—Subsurface sand fraction from Bighawk typical pedon.

Figure 11.—An area of Bighawk family sand, 2 to 11 percent slopes.

101—Bighawk family gravelly sand, 2 to 11 percent slopes

Map Unit Setting

Landform(s): Alluvial fans (fig. 11)
Elevation: 4,760 to 5,090 feet (1,450 to 1,552 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Bighawk family and similar soils: 85 percent
Minor components: Torriorthents—15 percent

Description of the Bighawk Family, Tephra Soil

Taxonomic classification: Ashy-skeletal, glassy, mesic Vitrandic Haplocambids
Taxon kind: Family
Geomorphic position: Toeslopes beneath cinder cones
Parent material: Tephra over residuum
Elevation: 4,760 to 5,090 feet (1,450 to 1,552 meters)
Slope: 2 to 11 percent
Depth to restrictive feature(s): 40 to 60 inches to lithic bedrock

Figure 12.—Surface of Bighawk family gravelly sand, in a very gravelly area.

Drainage class: Somewhat excessively drained
K_{sat} in solum: 0.57 inch to 99.92 inches per hour (4.00 to 705.00 micrometers per second)
K_{sat} in restrictive layer: 0.00 to 0.06 inch per hour (0.00 to 0.42 micrometer per second)
Available water capacity (total inches): 4.6 (low)
Shrink-swell potential: About 2.0 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very low
Hydrologic group: B
Ecological site name: Volcanic Upland 10-14” p.z.
Ecological site number: R035XA108AZ
Present vegetation: Black grama, bush muhly, oneseed juniper, Cutler’s jointfir, galleta, rubber rabbitbrush, sand sagebrush, wolfberry, Apache plume, and fourwing saltbush
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 12)

Canopy plant cover	44
Woody debris	0
Herbaceous litter	18
Bare soil	0
Rock fragments (tephra)	20

Typical Pedon (figs. 13 through 16)

Location by Universal Transverse Mercator System: Zone 12N, 3934108 Northing, 465467 Easting

Figure 13.—Profile of Bighawk family soil. Scale is in centimeters.

C1—0 to 2 inches (0 to 5 centimeters); dark grayish brown (10YR 4/2) gravelly sand, black (7.5YR 2.5/1) moist; 2 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; common interstitial pores; 30 percent cinders; noneffervescent; moderately alkaline, pH 8.2; abrupt smooth boundary.

C2—2 to 9 inches (5 to 21 centimeters); black (7.5YR 2.5/1) very gravelly sand, black (10YR 2/1) moist; 4 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; many interstitial pores; 35 percent cinders; slightly effervescent, 3 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; abrupt smooth boundary.

2Bk1—9 to 13 inches (21 to 32 centimeters); brown (7.5YR 5/4) loam, brown (7.5YR 4/3) moist; 21 percent clay; massive; hard, friable, slightly sticky, slightly plastic; many very fine roots throughout; common medium vesicular pores; finely disseminated carbonate in matrix and common fine carbonate masses infused into

Figure 14.—Box sample of Bighawk family typical pedon.

matrix along faces of peds; 10 percent cinders; violently effervescent, 11 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt smooth boundary.

2Bk2—13 to 29 inches (32 to 74 centimeters); pale red (2.5YR 6/2) extremely gravelly loamy sand, weak red (2.5YR 4/2) moist; 6 percent clay; massive; loose, nonsticky, nonplastic; common very fine and fine roots throughout; many interstitial pores; common carbonate masses around rock fragments; 10 percent cobbles and 55 percent cinders; strongly effervescent, 10 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; clear smooth boundary.

2Bk3—29 to 46 inches (74 to 117 centimeters); pale brown (10YR 6/3) gravelly loamy sand, dark grayish brown (10YR 4/2) moist; 7 percent clay; massive; loose, nonsticky, nonplastic; common very fine and fine roots throughout; many interstitial pores; common carbonate masses around rock fragments and finely disseminated

Figure 15.—Surface sand fraction from Bighawk family typical pedon.

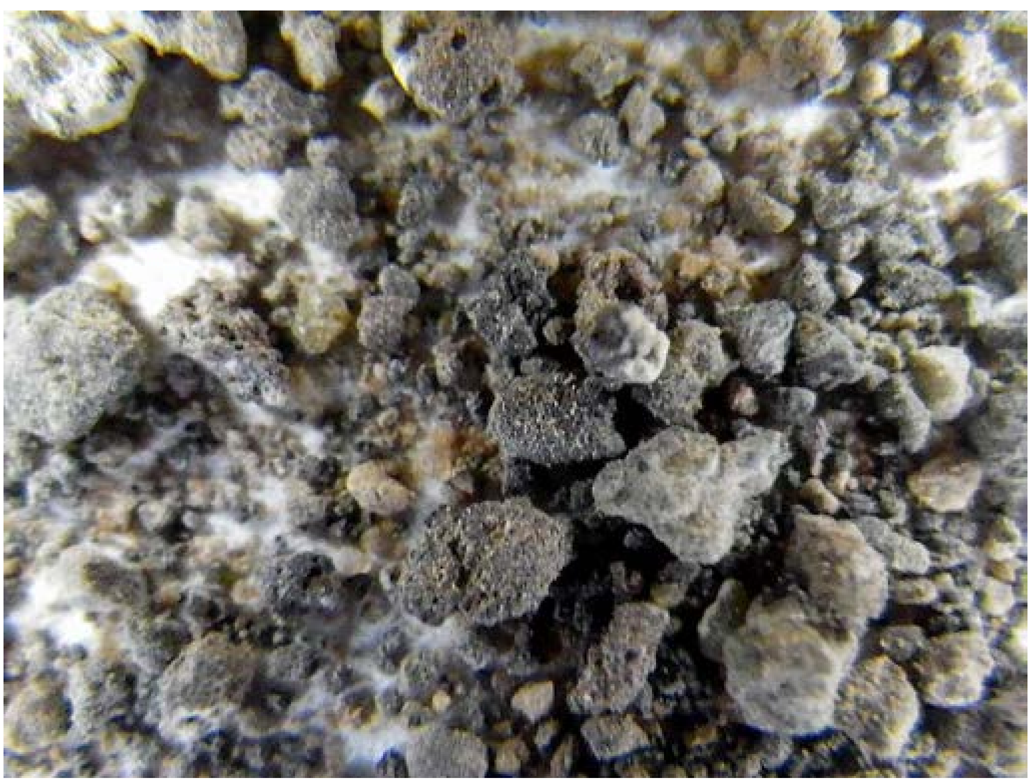


Figure 16.—Subsurface sand fraction from Bighawk family typical pedon.

carbonate; 20 percent cinders; violently effervescent, 10 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt wavy boundary.
3R—46 inches (117 centimeters); fractured, unweathered limestone.

Range in Characteristics

Note: Bighawk family soils are deep to a lithic bedrock contact and have a tephra cap whereas the Bighawk series is very deep and does not have a tephra cap.

Rock fragment content of the control section: 35 to 70 percent cinders
Clay content of particle-size control section: 3 to 18 percent
Volcanic glass content: 30 to 40 percent
Tephra cap: The zone from 0 to 9 inches (0 to 21 centimeters) (C1 and C2 horizons)
Cambic horizon: The zone from 8 to 46 inches (21 to 117 centimeters) (2Bk and 2Ck horizons)

C horizons:
Hue—5YR or 7.5YR
Value—2.5 to 4 dry; 2 to 3 moist
Chroma—1 or 2, dry or moist
Texture—coarse sand, loamy coarse sand, or sand
Clay content—1 to 10 percent
Calcium carbonate equivalent—2 to 5 percent
Rock fragments—15 to 75 percent cinders
Reaction—moderately alkaline or strongly alkaline

2Bk horizons:
Hue—2.5YR, 5YR, 7.5YR, or 10YR
Value—3 to 6 dry; 2.5 to 4 moist
Chroma—2 to 4, dry or moist
Texture—sandy loam, loamy sand, or sandy clay loam
Clay content—6 to 21 percent
Calcium carbonate equivalent—10 to 25 percent
Rock fragments—10 to 70 percent
Reaction—moderately alkaline or strongly alkaline

102—Chedeski very gravelly sandy loam, 0 to 6 percent slopes

Map Unit Setting

Landform(s): Structural benches (fig. 17)
Elevation: 5,280 to 5,480 feet (1,610 to 1,669 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Chedeski and similar soils: 90 percent
Minor components: Loamy, Lithic Ustic Torriorthents—10 percent

Description of the Chedeski, Tephra Soil

Taxonomic classification: Loamy, mixed, superactive, mesic, shallow Ustic Haplocambids

Figure 17.—An area of Chedeski very gravelly sandy loam, 0 to 6 percent slopes.

Taxon kind: Series
Geomorphic position: Toeslopes beneath relict lava fields and rises on flat structural benches
Parent material: Cinders derived from volcanic rock over residuum weathered from sandstone and shale
Elevation: 5,280 to 5,480 feet (1,610 to 1,669 meters)
Slope: 0 to 6 percent
Depth to restrictive feature(s): 3 to 20 inches to paralithic bedrock; 10 to 40 inches to lithic bedrock
Drainage class: Well drained
K_{sat} in solum: 0.20 inch to 19.98 inches per hour (1.40 to 141.00 micrometers per second)
K_{sat} in restrictive layer: 0.00 to 0.60 inch per hour (0.00 to 4.23 micrometers per second)
Available water capacity (total inches): 1.6 (very low)
Shrink-swell potential: About 2.7 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Medium
Hydrologic group: D
Ecological site name: Volcanic Upland 10-14” p.z.
Ecological site number: R035XA108AZ
Present vegetation: Galleta, oneseed juniper, black grama, Indian ricegrass, needle and thread, and threeawn
Land capability (nonirrigated areas): 6c

Figure 18.—Surface of Chedeski very gravelly sandy loam.

Surface cover (percent): (fig. 18)

Canopy plant cover	16
Woody debris	0
Herbaceous litter	0
Bare soil	10
Rock fragments (tephra)	45

Typical Pedon (figs. 19 through 22)

Location by Universal Transverse Mercator System: Zone 12N, 3933061 Northing, 459259 Easting

C—0 to 2 inches (0 to 5 centimeters); 50 percent black (5YR 2.5/1) and 50 percent reddish brown (5YR 5/4) very gravelly sandy loam, 50 percent black (5YR 2.5/1) and 50 percent dark reddish brown (5YR 3/4) moist; 12 percent clay; single grain; loose, nonsticky, nonplastic; common medium and many very fine and fine roots throughout; common very fine dendritic tubular pores; 40 percent cinders; slightly effervescent, 3 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; clear smooth boundary.

2Bw—2 to 13 inches (5 to 33 centimeters); reddish brown (5YR 5/4) gravelly sandy clay loam, yellowish red (5YR 4/6) moist; 27 percent clay; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common medium and many very fine and fine roots throughout; 20 percent gravel; strongly effervescent, 10 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt wavy boundary.

2Cr—13 to 27 inches (33 to 69 centimeters); fractured, weathered shale; abrupt wavy boundary.

2R—27 inches (69 centimeters); fractured, unweathered sandstone.

Figure 19.—Profile of Chedeski soil. Scale is in centimeters.

Range in Characteristics

Rock fragment content of the control section: 15 to 35 percent
Clay content of particle-size control section: 18 to 27 percent
Tephra cap: The zone from 0 to 2 inches (0 to 5 centimeters) (C horizon)
Cambic horizon: The zone from 2 to 13 inches (5 to 33 centimeters) (Bw horizon)

C horizon:
Hue—5YR or 10YR
Value—2.5 to 5 dry; 2.5 or 4 moist
Chroma—1 to 4, dry or moist
Texture—sandy loam

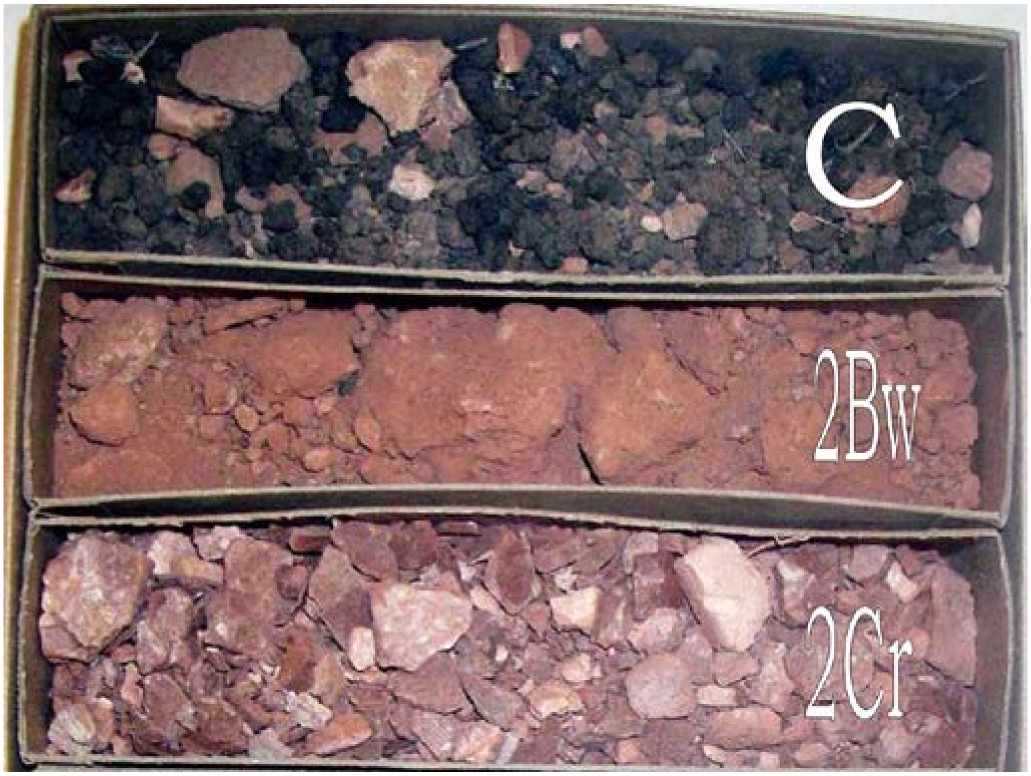


Figure 20.—Box sample of Chedeski typical pedon.

Figure 21.—Surface sand fraction from Chedeski typical pedon.

Figure 22.—Subsurface sand fraction from Chedeski typical pedon.

Clay content—8 to 18 percent
Calcium carbonate equivalent—2 to 5 percent
Rock fragments—20 to 50 percent cinders
Reaction—moderately alkaline

2Bw horizon:
Hue—5YR or 10YR
Value—4 to 6 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—sandy clay loam, loam, or sandy loam
Clay content—21 to 35 percent
Calcium carbonate equivalent—2 to 15 percent
Rock fragments—0 to 40 percent gravel
Reaction—moderately alkaline or strongly alkaline

103—Flaco extremely gravelly coarse sand, 1 to 3 percent slopes

Map Unit Setting

Landform(s): Lava fields (fig. 23)
Elevation: 5,250 to 5,710 feet (1,599 to 1,739 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days

Figure 23.—An area of Flaco extremely gravelly coarse sand, 1 to 3 percent slopes.

Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Flaco and similar soils: 90 percent
Minor components: Peshlaki soils—5 percent; Bighawk soils—5 percent

Description of the Flaco, Tephra Soil

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Ustic Calciargids
Taxon kind: Series
Geomorphic position: Talf on relict lava fields
Parent material: Residuum weathered from basalt
Elevation: 5,250 to 5,710 feet (1,599 to 1,739 meters)
Slope: 1 to 3 percent
Depth to restrictive feature(s): 20 to 40 inches to lithic bedrock
Drainage class: Well drained
K_{sat} *in solum:* 0.20 inch to 99.92 inches per hour (1.40 to 705.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.10 inch per hour (0.00 to 0.70 micrometers per second)
Available water capacity (total inches): 3.2 (low)
Shrink-swell potential: About 4.6 LEP (moderate)
Flooding hazard: None
Ponding hazard: None
Runoff class: Low
Hydrologic group: C

Figure 24.—Surface of Flaco coarse sand, in a gravelly area.

Ecological site name: Volcanic Upland 10-14” p.z.
Ecological site number: R035XA108AZ
Present vegetation: Galleta, Russian-thistle, black grama, needle and thread, and oneseed juniper
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 24)

Canopy plant cover	66
Woody debris	0
Herbaceous litter	18
Bare soil	4
Rock fragments (tephra)	40

Typical Pedon (figs. 25 through 28)

Location by Universal Transverse Mercator System: Zone 12N, 3933159 Northing, 451999 Easting

C1—0 to 1 inch (0 to 3 centimeters); black (7.5YR 2.5/1) extremely gravelly coarse sand, black (7.5YR 2.5/1) moist; 3 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; many interstitial pores; 60 percent cinders; noneffervescent; moderately alkaline, pH 8.0; abrupt smooth boundary.

C2—1 to 6 inches (3 to 15 centimeters); very dark grayish brown (10YR 3/2) gravelly sandy loam, black (10YR 2/1) moist; 17 percent clay; weak medium granular and thin platy structure; soft, very friable, slightly sticky, slightly plastic; many very fine and common fine roots throughout; common very fine dendritic tubular pores; 20 percent cinders; noneffervescent; moderately alkaline, pH 8.0; abrupt smooth boundary.

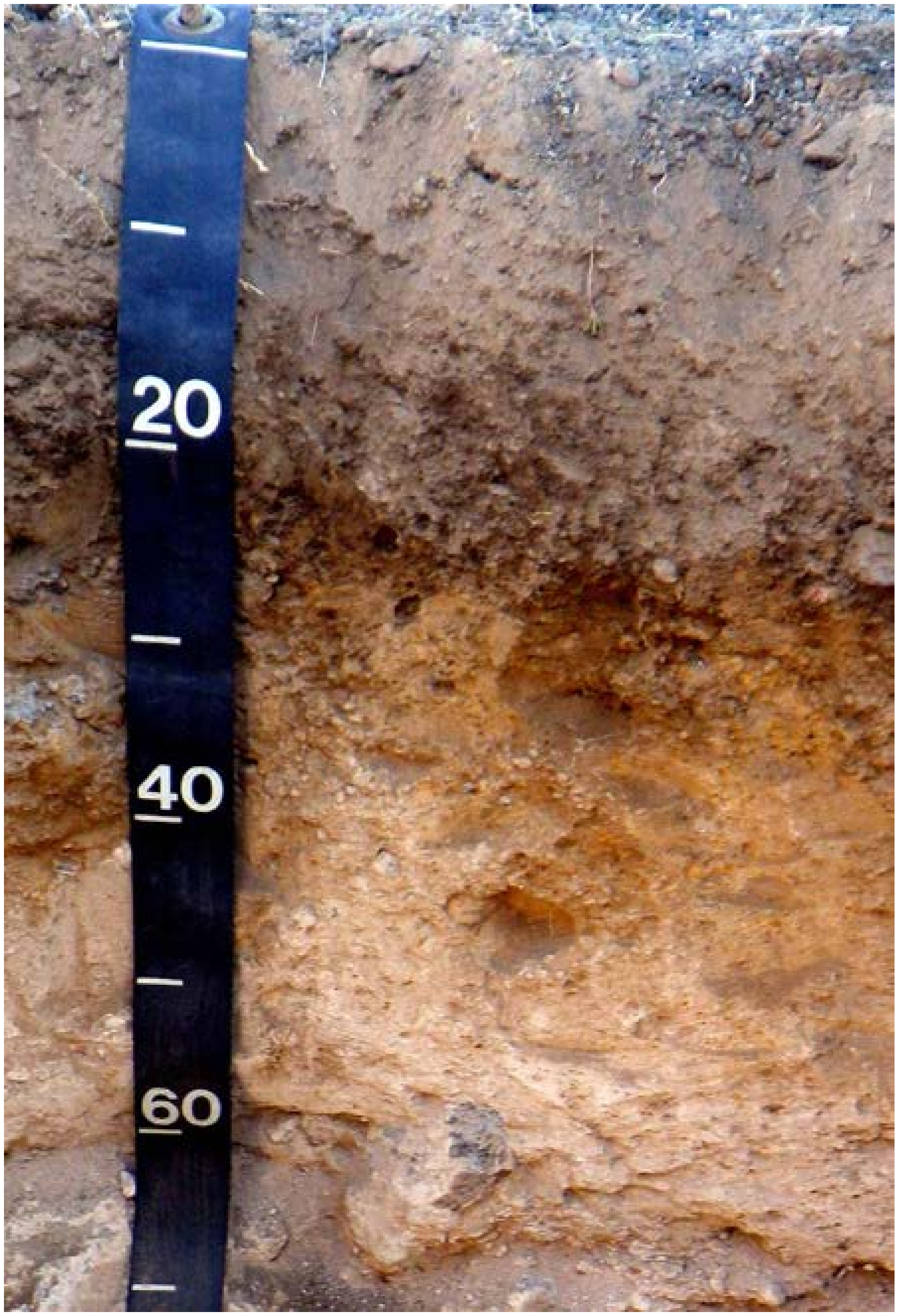


Figure 25.—Profile of Flaco soil. Scale is in centimeters.

2Bt—6 to 10 inches (15 to 25 centimeters); dark brown (10YR 3/3) sandy clay loam, black (10YR 2/2) moist; 33 percent clay; moderate medium angular blocky structure; slightly hard, friable, very sticky, moderately plastic; many very fine roots throughout; common very fine dendritic tubular pores; very few faint thin clay films on all faces of peds; slightly effervescent, 4 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; clear smooth boundary.

2Bk1—10 to 20 inches (25 to 51 centimeters); pale brown (10YR 6/3) gravelly sandy clay loam, brown (10YR 5/3) moist; 28 percent clay; weak medium subangular

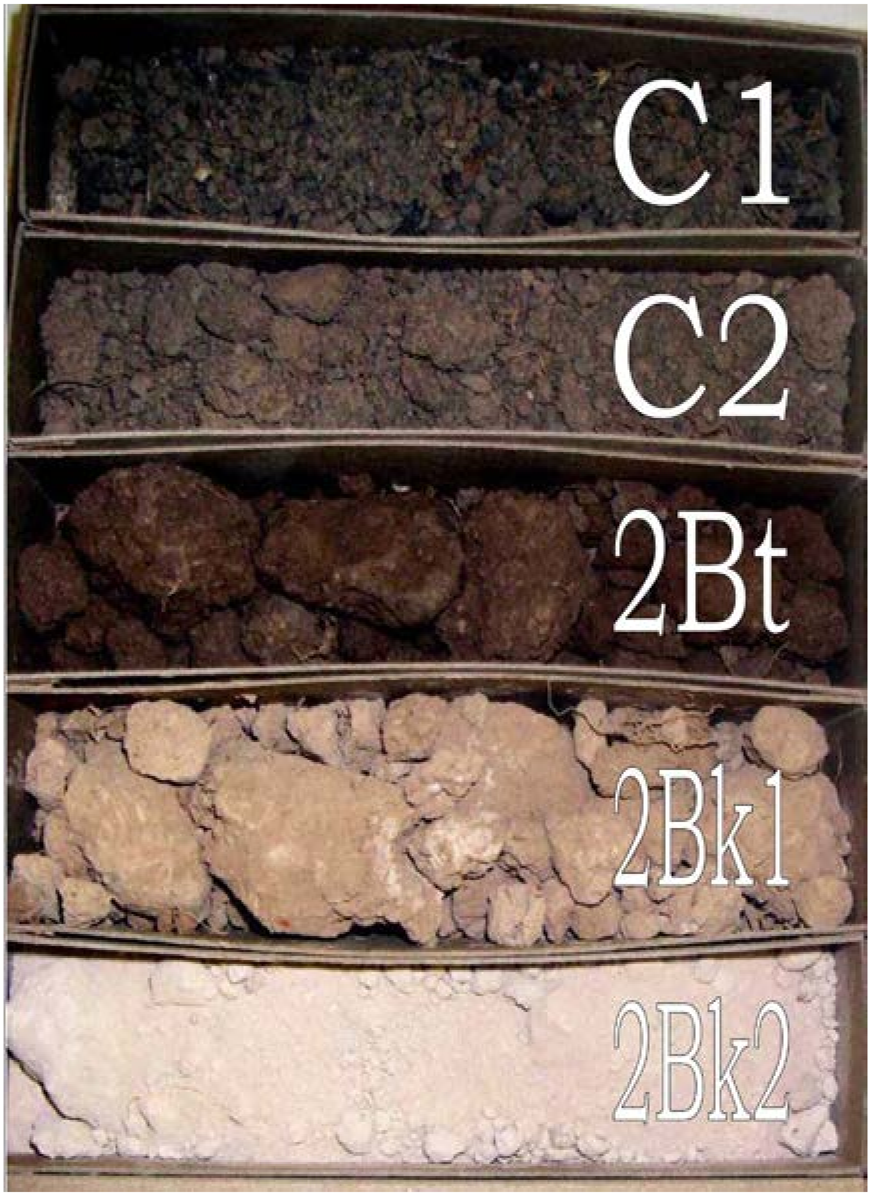


Figure 26.—Box sample of Flaco typical pedon.

blocky structure; slightly hard, friable, moderately sticky, moderately plastic; common very fine roots throughout; common very fine dendritic tubular pores; common carbonate masses in matrix; 5 percent cobbles and 22 percent gravel; strongly effervescent, 21 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; gradual wavy boundary.

2Bk2—20 to 31 inches (51 to 79 centimeters); light gray (10YR 7/2) gravelly sandy loam, brown (10YR 5/3) moist; 19 percent clay; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine roots throughout; common very fine irregular pores; common carbonate masses in matrix and around rock fragments; 30 percent gravel; violently effervescent, 40 percent calcium carbonate equivalent; strongly alkaline, pH 9.0; abrupt wavy boundary.

2R—31 inches (79 centimeters); fractured, unweathered basalt.

Figure 27.—Surface sand fraction from Flaco typical pedon.

Note: Table 31 shows lab data for this pedon (i.e., 12N7968).

Range in Characteristics

Rock fragment content of the control section: 0 to 20 percent
Clay content of particle-size control section: 24 to 35 percent
Tephra cap: The zone from 0 to 1 inch (0 to 3 centimeters) (C horizon)
Argillic horizon: The zone from 6 to 10 inches (15 to 25 centimeters) (2Bt horizon)
Calcic horizon: The zone from 10 to 31 inches (25 to 79 centimeters) (2Bk horizons)

C horizon:
Hue—7.5YR or 10YR
Value—2.5 or 3 dry; 2.5 moist
Chroma—1 or 2, dry or moist
Texture—coarse sand or sandy loam
Clay content—3 to 18 percent
Rock fragments—5 to 65 percent cinders
Reaction—moderately alkaline

2Bt horizon:
Hue—5YR or 10YR
Value—3 or 4 dry; 2.5 or 3 moist
Chroma—2 to 4, dry or moist
Texture—loam or sandy clay loam
Clay content—24 to 35 percent
Calcium carbonate equivalent—2 to 10 percent
Rock fragments—0 to 20 percent
Reaction—moderately alkaline or strongly alkaline

Figure 28.—Subsurface sand fraction from Flaco typical pedon.

2Bk horizons:
- Hue—7.5YR or 10YR
- Value—5 to 7 dry; 5 or 6 moist
- Chroma—2 to 4, dry or moist
- Texture—sandy clay loam, sandy loam, or loam
- Clay content—14 to 30 percent
- Carbonate equivalent—10 to 30 percent
- Rock fragments—10 to 35 percent
- Reaction—moderately alkaline or strongly alkaline

104—Flaco-Lava flows complex, 1 to 18 percent slopes

Map Unit Setting

Landform(s): Lava fields and lava flows (figs. 29 and 30)
Elevation: 4,980 to 5,710 feet (1,517 to 1,741 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Flaco and similar soils: 75 percent

Figure 29.—The Flaco soil in an area of Flaco-Lava flows complex, 1 to 18 percent slopes.

Figure 30.—Lava flows in an area of Flaco-Lava flows complex, 1 to 18 percent slopes.

Figure 31.—Surface of Flaco coarse sand.

Lava flows, basalt: 10 percent
Minor components: Peshlaki soils—10 percent; Bighawk soils—5 percent

Description of the Flaco, Tephra Soil

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Ustic Calciargids
Taxon kind: Series
Geomorphic position: Summits and shoulders
Parent material: Residuum weathered from basalt
Elevation: 4,980 to 5,710 feet (1,517 to 1,741 meters)
Slope: 1 to 18 percent
Depth to restrictive feature(s): 20 to 40 inches to lithic bedrock
Drainage class: Well drained
K_{sat} *in solum:* 0.20 inch to 99.92 inches per hour (1.40 to 705.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.10 inch per hour (0.00 to 0.70 micrometer per second)
Available water capacity (total inches): 3.6 (low)
Shrink-swell potential: About 3.2 LEP (moderate)
Flooding hazard: None
Ponding hazard: None
Runoff class: Low
Hydrologic group: C
Ecological site name: Volcanic Upland 10-14” p.z.
Ecological site number: R035XA108AZ
Present vegetation: Galleta, oneseed juniper, alkali sacaton, black grama, Apache plume, sideoats grama, milkweed, and four o’clock
Land capability (nonirrigated areas): 6c

Figure 32.—Profile of Flaco soil. Scale is in inches.

Surface cover (percent): (fig. 31)

Canopy plant cover	52
Woody debris	0
Herbaceous litter	28
Bare soil	0
Rock fragments (tephra)	35

Typical Pedon (figs. 32 through 35)

Location by Universal Transverse Mercator System: Zone 12N, 3933159 Northing, 456474 Easting

Figure 33.—Box sample of Flaco typical pedon.

C1—0 to 1 inch (0 to 3 centimeters); black (7.5YR 2.5/1) very stony coarse sand, black (7.5YR 2.5/1) moist; 3 percent clay; single grain; loose, nonsticky, nonplastic; many very fine roots throughout; many interstitial pores; 20 percent stones and 20 percent cinders; slightly effervescent, 1 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; clear smooth boundary.

C2—1 to 7 inches (3 to 18 centimeters); brown (10YR 4/3) very gravelly sandy loam, dark brown (10YR 3/3) moist; 17 percent clay; weak thin platy structure; soft, very friable, slightly sticky, slightly plastic; few medium and many very fine roots throughout; common very fine dendritic tubular pores; 5 percent cobbles and 30 percent cinders; strongly effervescent, 4 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; abrupt smooth boundary.

2Bt—7 to 10 inches (18 to 25 centimeters); very dark grayish brown (10YR 3/2) gravelly sandy clay loam, very dark grayish brown (10YR 3/2) moist; 30 percent

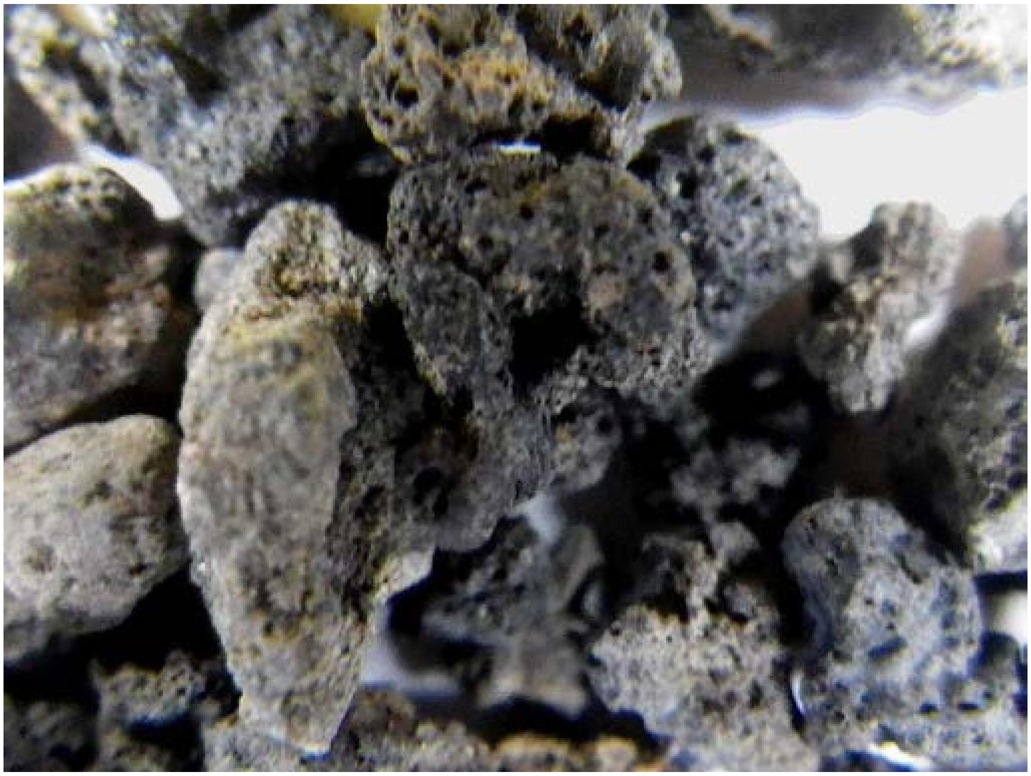


Figure 34.—Surface sand fraction from Flaco typical pedon.

Figure 35.—Subsurface sand fraction from Flaco typical pedon.

clay; moderate medium angular blocky structure; slightly hard, friable, moderately sticky, moderately plastic; many very fine roots throughout; common very fine dendritic tubular pores; very few faint thin clay films on all faces of peds; 5 percent cobbles and 15 percent gravel; violently effervescent, 10 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; abrupt smooth boundary.

2Bk1—10 to 18 inches (25 to 46 centimeters); dark yellowish brown (10YR 4/4) gravelly loam, dark brown (10YR 3/3) moist; 22 percent clay; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine roots throughout; many very fine dendritic tubular pores; common carbonate masses in matrix; 5 percent cobbles and 10 percent gravel; violently effervescent, 14 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; clear wavy boundary.

2Bk2—18 to 31 inches (46 to 79 centimeters); brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; 20 percent clay; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine roots throughout; many very fine dendritic tubular pores; common carbonate masses in matrix; 5 percent cobbles and 10 percent gravel; violently effervescent, 32 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt wavy boundary.

2R—31 inches (79 centimeters); fractured, unweathered basalt.

Range in Characteristics

Rock fragment content of the control section: 0 to 25 percent
Clay content of particle-size control section: 24 to 35 percent
Tephra cap: The zone from 0 to 1 inch (0 to 3 centimeters) (C1 horizon)
Argillic horizon: The zone from 7 to 10 inches (18 to 25 centimeters) (2Bt horizon)
Calcic horizon: The zone from 10 to 31 inches (25 to 79 centimeters) (2Bk horizons)

C horizons:
Hue—7.5YR or 10YR
Value—2.5 to 4 dry; 2.5 or 3 moist
Chroma—1 to 3, dry or moist
Texture—coarse sand or sandy loam
Clay content—3 to 18 percent
Calcium carbonate equivalent—0 to 10 percent
Rock fragments—15 to 65 percent cinders
Reaction—slightly alkaline or moderately alkaline

2Bt horizon:
Hue—5YR or 10YR
Value—3 or 4, dry or moist
Chroma—2 to 4, dry or moist
Texture—loam or sandy clay loam
Clay content—24 to 35 percent
Calcium carbonate equivalent—5 to 10 percent
Rock fragments—0 to 25 percent
Reaction—moderately alkaline or strongly alkaline

2Bk horizons:
Hue—7.5YR or 10YR
Value—4 to 7 dry; 3 to 6 moist
Chroma—2 to 4, dry or moist
Texture—sandy loam, loam, or sandy clay loam
Clay content—14 to 30 percent
Carbonate equivalent—10 to 40 percent

Figure 36.—The Flaco soil in an area of Flaco-Pocum complex, 1 to 3 percent slopes.

Rock fragments—10 to 35 percent
Reaction—moderately alkaline or strongly alkaline

Description of Lava Flows, Basalt

Lava flows typically have weathered surfaces, crevices, and angular blocks that are characteristic of lava flows of the Pleistocene Epoch. Earthy material has accumulated in rocks and sheltered pockets, but the flows are virtually devoid of vegetation with the exception of lichens.

105—Flaco-Pocum complex, 1 to 3 percent slopes

Map Unit Setting

Landform(s): Terraces (figs. 36 and 37)
Elevation: 5,270 to 5,500 feet (1,605 to 1,676 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Flaco and similar soils: 65 percent
Pocum and similar soils: 25 percent
Minor components: Haplustolls and Calciustolls—10 percent

Figure 37.—The Pocum soil in an area of Flaco-Pocum complex, 1 to 3 percent slopes.

Description of the Flaco, Tephra Soil

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Ustic Calciargids
Taxon kind: Series
Geomorphic position: Rises of relict terrace deposits
Parent material: Alluvium derived from volcanic rock
Elevation: 5,270 to 5,500 feet (1,605 to 1,676 meters)
Slope: 1 to 3 percent
Depth to restrictive feature(s): 20 to 40 inches to lithic bedrock
Drainage class: Well drained
K_{sat} *in solum:* 0.20 inch to 99.92 inches per hour (1.40 to 705.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.06 inch per hour (0.00 to 0.42 micrometer per second)
Available water capacity (total inches): 3.5 (low)
Shrink-swell potential: About 3.6 LEP (moderate)
Flooding hazard: None
Ponding hazard: None
Runoff class: Low
Hydrologic group: C
Ecological site name: Loamy Upland 10-14” p.z.
Ecological site number: R035XA113AZ
Present vegetation: Galleta, needle and thread, rubber rabbitbrush, alkali sacaton, oneseed juniper, and black grama
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 38)

Canopy plant cover	60
Woody debris	0

Figure 38.—Surface of Flaco sand.

Herbaceous litter	0
Bare soil	2
Rock fragments (tephra)	25

Typical Pedon (figs. 39 through 42)

Location by Universal Transverse Mercator System: Zone 12N, 3936989 Northing, 459802 Easting

C—0 to 2 inches (0 to 5 centimeters); dark brown (7.5YR 3/2) sand, black (7.5YR 2.5/1) moist; 3 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; many interstitial pores; 10 percent cinders; noneffervescent; moderately alkaline, pH 8.0; clear smooth boundary.

2Bw—2 to 6 inches (5 to 15 centimeters); brown (7.5YR 4/4) sandy clay loam, brown (7.5YR 4/3) moist; 23 percent clay; weak thin platy structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine roots throughout; common very fine dendritic tubular pores; 10 percent gravel; slightly effervescent, 3 percent calcium carbonate equivalent; moderately alkaline, pH 8.0; abrupt smooth boundary.

2Btk—6 to 14 inches (15 to 36 centimeters); strong brown (7.5YR 5/6) sandy clay loam, strong brown (7.5YR 4/6) moist; 30 percent clay; moderate medium subangular blocky structure; slightly hard, friable, moderately sticky, moderately plastic; few medium and many very fine roots throughout; many very fine dendritic tubular pores; very few distinct clay films on all faces of peds; common carbonate masses in matrix and finely disseminated carbonate throughout; 10 percent gravel; strongly effervescent, 21 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; clear wavy boundary.

Figure 39.—Profile of Flaco soil. Scale is in centimeters.

2Bk—14 to 25 inches (36 to 64 centimeters); light brown (7.5YR 6/4) gravelly sandy clay loam, brown (7.5YR 5/4) moist; 25 percent clay; moderate medium subangular blocky structure; slightly hard, friable, moderately sticky, slightly plastic; common medium and many very fine roots throughout; common very fine dendritic tubular pores; finely disseminated carbonate throughout and common carbonate masses in matrix; 15 percent gravel; violently effervescent, 31 percent calcium carbonate equivalent; strongly alkaline, pH 9.0; abrupt wavy boundary.

3R—25 inches (64 centimeters); fractured, unweathered limestone.

Note: Table 31 shows lab data for this pedon (i.e., 12N7970).

Figure 40.—Box sample of Flaco typical pedon.

Figure 41.—Surface sand fraction from Flaco typical pedon.

Figure 42.—Subsurface sand fraction from Flaco typical pedon.

Range in Characteristics

Rock fragment content of the control section: 5 to 30 percent
Clay content of particle-size control section: 20 to 32 percent
Tephra cap: The zone from 0 to 2 inches (0 to 5 centimeters) (C horizon)
Argillic horizon: The zone from 6 to 14 inches (15 to 36 centimeters) (Btk horizon)
Calcic horizon: The zone from 6 to 25 inches (15 to 64 centimeters) (Btk and Bk horizons)

C horizon:
Hue—7.5YR or 10YR
Value—2.5 or 3 dry; 2.5 moist
Chroma—1 or 2, dry or moist
Texture—sand
Clay content—2 to 5 percent
Rock fragments—10 to 50 percent cinders
Reaction—moderately alkaline

2Bw or 2Btk horizon:
Hue—7.5YR or 10YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—3 to 6, dry or moist
Texture—sandy clay loam or loam
Clay content—20 to 32 percent
Calcium carbonate equivalent—2 to 20 percent
Rock fragments—10 to 25 percent
Reaction—moderately alkaline or strongly alkaline

2Bk horizon:
Hue—7.5YR or 10YR
Value—5 or 6 dry; 4 or 5 moist
Chroma—3 to 6, dry or moist
Texture—sandy clay loam or loam
Clay content—20 to 32 percent
Calcium carbonate equivalent—15 to 30 percent
Rock fragments—10 to 30 percent
Reaction—moderately alkaline or strongly alkaline

Description of the Pocum, Tephra Soil

Taxonomic classification: Loamy, mixed, superactive, mesic, shallow Calcic Petrocalcids
Taxon kind: Series
Geomorphic position: Dips in relict terrace deposits
Parent material: Alluvium derived from volcanic rock over residuum weathered from limestone
Elevation: 5,270 to 5,500 feet (1,605 to 1,676 meters)
Slope: 1 to 3 percent
Depth to restrictive feature(s): 10 to 20 inches to petrocalcic horizon; 10 to 40 inches to lithic bedrock
Drainage class: Well drained
K_{sat} *in solum:* 0.01 inch to 99.92 inches per hour (0.10 micrometer to 705.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.06 inch per hour (0.00 to 0.42 micrometer per second)
Available water capacity (total inches): 1.8 (very low)
Shrink-swell potential: About 2.4 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Medium
Hydrologic group: D
Ecological site name: Loamy Upland 10-14” p.z.
Ecological site number: R035XA113AZ
Present vegetation: Galleta, needle and thread, alkali sacaton, black grama, oneseed juniper, and rubber rabbitbrush
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 43)

Canopy plant cover	66
Woody debris	0
Herbaceous litter	6
Bare soil	4
Rock fragments (tephra)	15

Typical Pedon (figs. 44 through 47)

Location by Universal Transverse Mercator System: Zone 12N, 3936824 Northing, 460520 Easting

C—0 to 2 inches (0 to 5 centimeters); black (7.5YR 2.5/1) gravelly coarse sand, black (7.5YR 2/1) moist; 3 percent clay; single grain; loose, nonsticky, nonplastic; many very fine and common fine roots throughout; many interstitial pores; 20 percent gravel; noneffervescent; moderately alkaline, pH 8.0; abrupt smooth boundary.

2Bw—2 to 9 inches (5 to 23 centimeters); brown (7.5YR 4/4) gravelly sandy clay loam, dark brown (7.5YR 3/3) moist; 23 percent clay; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common medium and many very fine roots throughout; common very fine irregular and

Figure 43.—Surface of Pocum gravelly coarse sand.

Figure 44.—Profile of Pocum soil. Scale is in centimeters.

Figure 45.—Box sample of Pocum typical pedon.

common fine irregular pores; 15 percent gravel; slightly effervescent, 5 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; clear smooth boundary.

2Bk—9 to 18 inches (23 to 46 centimeters); light brown (7.5YR 6/3) gravelly sandy loam, brown (7.5YR 4/3) moist; 16 percent clay; moderate medium platy and angular blocky structure; hard, friable, slightly sticky, slightly plastic; common medium and many very fine roots throughout; many very fine dendritic tubular pores; many carbonate nodules in matrix and finely disseminated carbonate throughout; 5 percent cobbles and 15 percent gravel; violently effervescent, 38 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; clear wavy boundary.

2Bkm—18 to 22 inches (46 to 56 centimeters); light brown (7.5YR 6/3) loamy sand, brown (7.5YR 4/3) moist; many very fine roots at top of horizon; moderately cemented petrocalcic materials; abrupt smooth boundary.

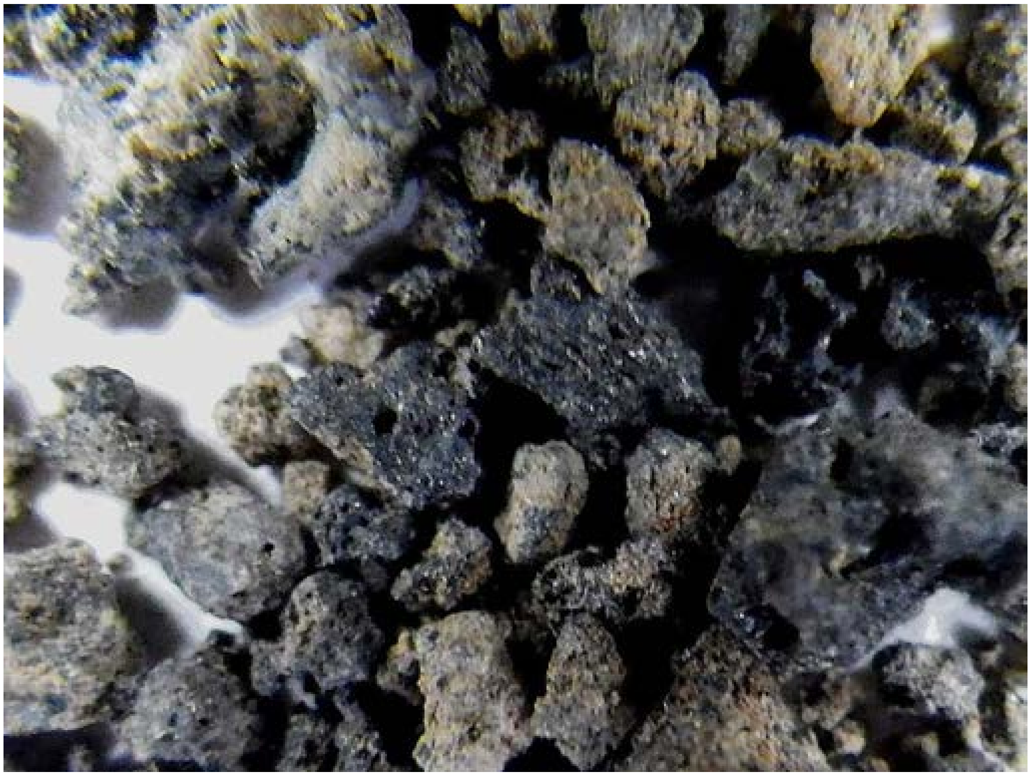


Figure 46.—Surface sand fraction from Pocum typical pedon.

Figure 47.—Subsurface sand fraction from Pocum typical pedon.

2B´k—22 to 25 inches (56 to 64 centimeters); light brown (7.5YR 6/3) gravelly sandy loam, brown (7.5YR 5/3) moist; 18 percent clay; massive; hard, friable, slightly sticky, slightly plastic; finely disseminated carbonate throughout; 25 percent gravel; violently effervescent, 39 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt wavy boundary.
3R—25 inches (64 centimeters); fractured, unweathered limestone.

Range in Characteristics

Rock fragment content of the control section: 10 to 30 percent
Clay content of particle-size control section: 15 to 18 percent
Tephra cap: The zone from 0 to 2 inches (0 to 5 centimeters) (C horizon)
Calcic horizon: The zone from 9 to 18 inches (23 to 46 centimeters) (Bk horizon)
Petrocalcic horizon: The zone from 18 to 22 inches (46 to 56 centimeters) (Bkm horizon)

C horizon:
Hue—7.5YR or 10YR
Value—2.5 or 3 dry; 2 or 2.5 moist
Chroma—1 or 2, dry or moist
Texture—coarse sand
Clay content—2 to 5 percent
Rock fragments—10 to 50 percent cinders
Reaction—moderately alkaline

2Bw horizon:
Hue—7.5YR or 10YR
Value—4 to 6 dry; 3 or 4 moist
Chroma—3 to 6, dry or moist
Texture—sandy clay loam, loam, or sandy loam
Clay content—15 to 25 percent
Calcium carbonate equivalent—2 to 15 percent
Rock fragments—10 to 25 percent
Reaction—moderately alkaline or strongly alkaline

2Bk or 2B´k horizon:
Hue—7.5YR or 10YR
Value—5 or 6 dry; 4 or 5 moist
Chroma—3 to 6, dry or moist
Texture—sandy loam, sandy clay loam, or loam
Clay content—15 to 25 percent
Calcium carbonate equivalent—15 to 40 percent
Rock fragments—10 to 30 percent
Reaction—moderately alkaline or strongly alkaline

Bkm horizon:
Cementation—calcium carbonate
Thickness—4 to 8 inches
Hardness—moderately cemented or strongly cemented

106—Gish very gravelly coarse sand, 0 to 0.4 percent slopes

Map Unit Setting

Landform(s): Lakebeds (relict) (fig. 48)
Elevation: 5,340 to 5,550 feet (1,628 to 1,693 meters)

Figure 48.—An area of Gish very gravelly coarse sand, 0 to 0.4 percent slopes.

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Gish and similar soils: 90 percent
Minor components: Fine, Ustic Haplargids—10 percent

Description of the Gish, Tephra Soil

Taxonomic classification: Fine, mixed, superactive, mesic Ustic Haplocambids
Taxon kind: Series
Geomorphic position: Talf in relict lakebeds
Parent material: Lacustrine deposits derived from igneous and sedimentary rock
Elevation: 5,340 to 5,550 feet (1,628 to 1,693 meters)
Slope: 0 to 0.4 percent
Drainage class: Well drained
K_{sat} *in solum:* 0.01 inch to 99.92 inches per hour (0.04 micrometer to 705.00 micrometers per second)
Available water capacity (total inches): 9.3 (high)
Shrink-swell potential: About 6.0 LEP (high)
Flooding hazard: None
Ponding hazard: None
Runoff class: Low

Figure 49.—Surface of Gish very gravelly coarse sand.

Hydrologic group: C
Ecological site name: Loamy Upland 10-14” p.z.
Ecological site number: R035XA113AZ
Present vegetation: Galleta, alkali sacaton, rubber rabbitbrush, forbs, and annuals
Land capability (nonirrigated areas): 5c
Surface cover (percent): (fig. 49)

Canopy plant cover	60
Woody debris	2
Herbaceous litter	18
Bare soil	10
Rock fragments (tephra)	45

Typical Pedon (figs. 50 through 53)

Location by Universal Transverse Mercator System: Zone 12N, 3937089 Northing, 455913 Easting

C1—0 to 1 inch (0 to 2 centimeters); very dark gray (7.5YR 3/1) very gravelly coarse sand, black (7.5YR 2.5/1) moist; 1 percent clay; single grain; loose, nonsticky, nonplastic; common medium and very fine roots throughout; 40 percent cinders; noneffervescent; slightly alkaline, pH 7.6; abrupt smooth boundary.

C2—1 to 4 inches (2 to 9 centimeters); brown (7.5YR 5/3) gravelly coarse sandy loam, dark brown (7.5YR 3/3) moist; 12 percent clay; weak medium granular and platy structure; loose, nonsticky, nonplastic; many very fine and common fine roots throughout; 25 percent cinders; very slightly effervescent, 1 percent calcium carbonate equivalent; slightly alkaline, pH 7.6; abrupt smooth boundary.

2Bw—4 to 16 inches (9 to 39 centimeters); brown (7.5YR 5/4) clay loam, brown (7.5YR 4/3) moist; 39 percent clay; strong fine angular blocky structure; moderately hard,

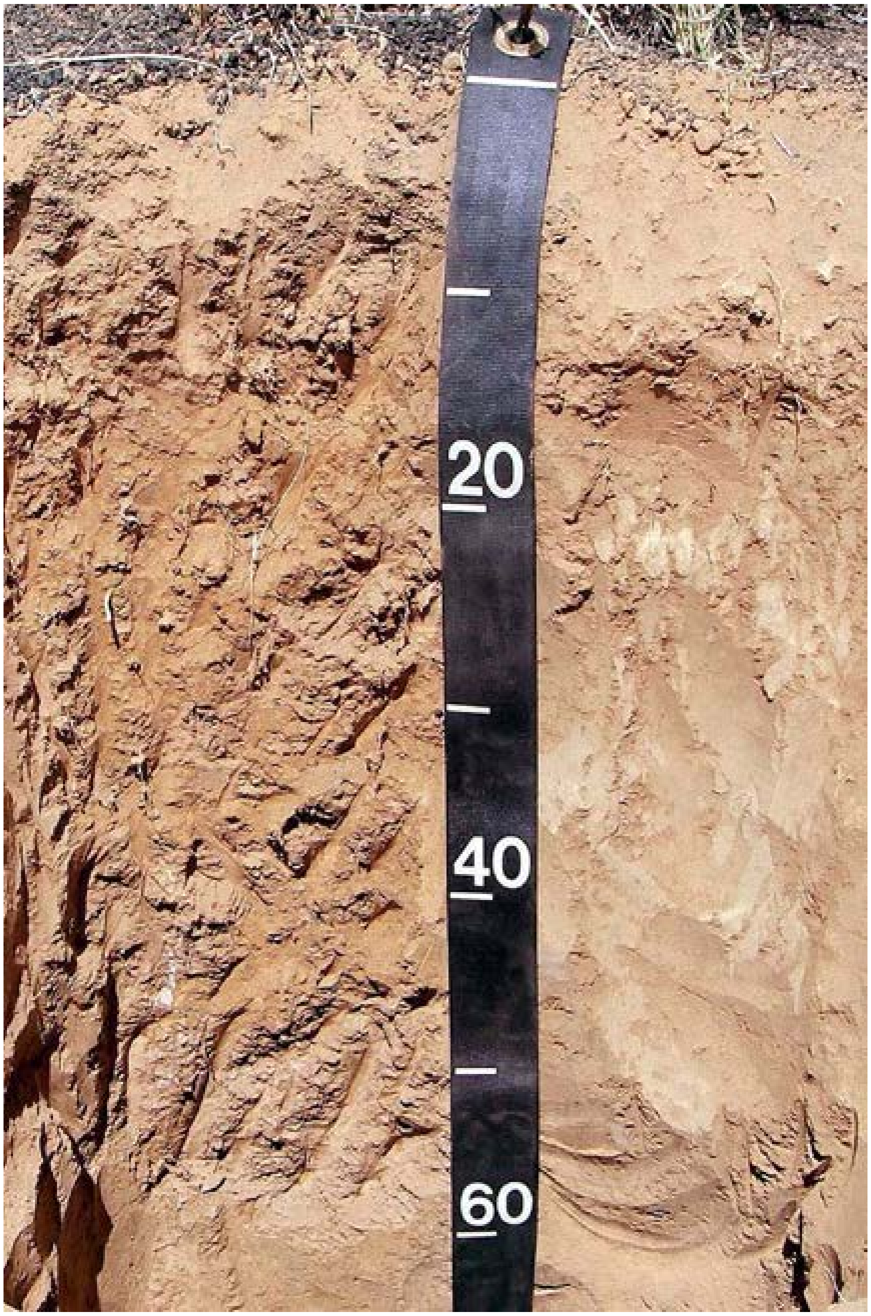


Figure 50.—Profile of Gish soil. Scale is in centimeters.

friable, very sticky, very plastic; common very fine roots throughout; many very fine and common fine tubular pores; slightly effervescent, 3 percent calcium carbonate equivalent; slightly alkaline, pH 7.8; clear smooth boundary.

2Bk1—16 to 30 inches (39 to 76 centimeters); light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 4/4) moist; 33 percent clay; moderate medium subangular blocky structure; moderately hard, friable, very sticky, very plastic; few very fine roots throughout; common very fine tubular pores; few carbonate nodules in matrix throughout; strongly effervescent, 12 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; gradual smooth boundary.

Figure 51.—Box sample of Gish typical pedon.

2Bk2—30 to 60 inches (76 to 152 centimeters); light brown (7.5YR 6/4) clay, brown (7.5YR 4/4) moist; 40 percent clay; weak fine subangular blocky structure; hard, firm, very sticky, very plastic; few carbonate nodules in matrix throughout; violently effervescent, 15 percent calcium carbonate equivalent; moderately alkaline, pH 8.2.

Range in Characteristics

Rock fragment content of the control section: 0 to 10 percent
Clay content of particle-size control section: 35 to 42 percent
Tephra cap: The zone from 0 to 1 inch (0 to 2 centimeters) (C1 horizon)
Cambic horizon: The zone from 4 to 30 inches (9 to 76 centimeters) (Bw and Bk1 horizons)

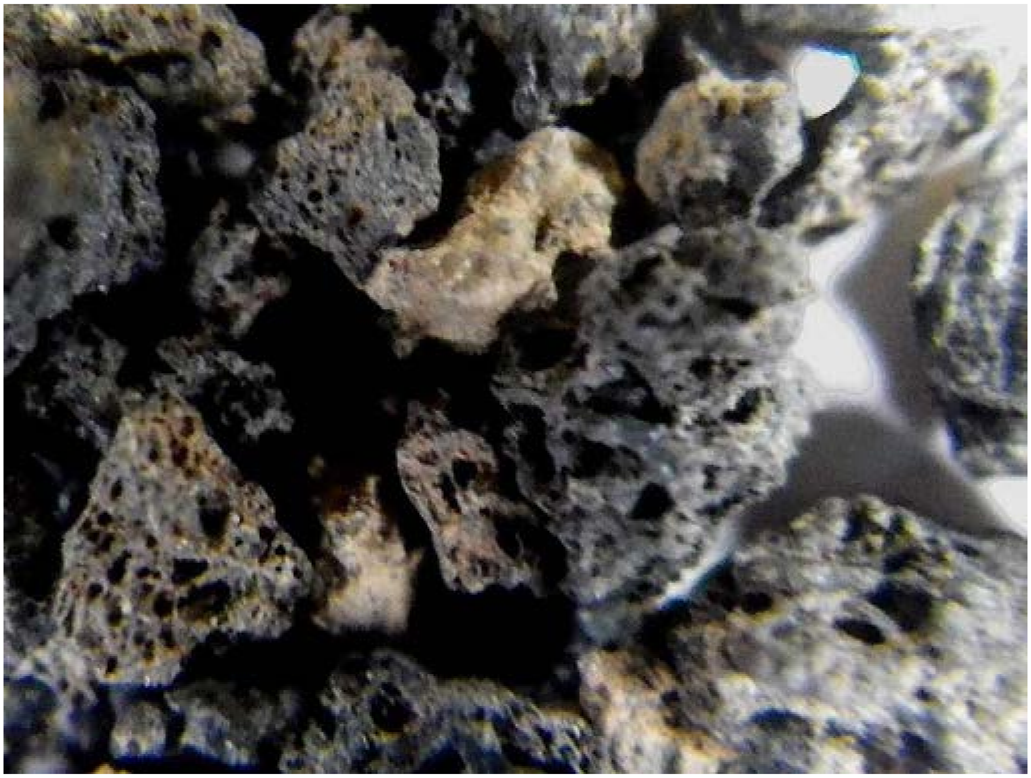


Figure 52.—Surface sand fraction of Gish typical pedon.

Figure 53.—Subsurface sand fraction of Gish typical pedon.

C horizons:
Hue—7.5YR or 10YR
Value—2.5 to 5 dry; 2.5 or 3 moist
Chroma—1 to 3, dry or moist
Texture—coarse sand or coarse sandy loam
Clay content—1 to 15 percent
Calcium carbonate equivalent—0 to 2 percent
Rock fragments—25 to 60 percent cinders
Reaction—slightly alkaline

2Bw horizon:
Hue—7.5YR or 10YR
Value—4 to 6 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—clay loam, sandy clay loam, or clay
Clay content—31 to 42 percent
Calcium carbonate equivalent—2 to 15 percent
Rock fragments—0 to 5 percent
Reaction—slightly alkaline or moderately alkaline

2Bk horizons:
Hue—7.5YR or 10YR
Value—4 to 6 dry; 3 to 5 moist
Chroma—4 to 6, dry or moist
Texture—clay, clay loam, or sandy clay loam
Clay content—28 to 42 percent
Calcium carbonate equivalent—10 to 25 percent
Rock fragments—0 to 10 percent
Reaction—slightly alkaline or moderately alkaline

107—Ives-Riverwash complex, rarely flooded, 1 to 5 percent slopes

Map Unit Setting

Landform(s): Channels (figs. 54 and 55)
Elevation: 4,290 to 4,640 feet (1,307 to 1,414 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Ives and similar soils: 60 percent
Riverwash: 20 percent
Minor components: Moenkopie soils—10 percent; Haplocambids—5 percent; Torriorthents—5 percent

Description of the Ives Soil

Taxonomic classification: Coarse-loamy, mixed, superactive, calcareous, mesic Typic Torrifluvents
Taxon kind: Series
Geomorphic position: Channels

Figure 54.—The Ives soil in an area of Ives-Riverwash complex, rarely flooded, 1 to 5 percent slopes.

Figure 55.—Riverwash in an area of Ives-Riverwash complex, rarely flooded, 1 to 5 percent slopes.

Figure 56.—Surface of Ives sandy clay loam.

Parent material: Alluvium derived from sedimentary rock
Elevation: 4,290 to 4,640 feet (1,307 to 1,414 meters)
Slope: 1 to 5 percent
Drainage class: Well drained
K_{sat} *in solum:* 0.20 inch to 5.95 inches per hour (1.40 to 42.00 micrometers per second)
Available water capacity (total inches): 4.5 (low)
Shrink-swell potential: About 2.8 LEP (low)
Flooding hazard: Rare
Ponding hazard: None
Runoff class: Low
Hydrologic group: C
Ecological site name: Loamy Wash 6-10” p.z.
Ecological site number: R035XB209AZ
Present vegetation: Fourwing saltbush and alkali sacaton
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 56)

Canopy plant cover	10
Woody debris	0
Herbaceous litter	4
Bare soil	98
Rock fragments (gravel)	5

Typical Pedon (figs. 57 through 60)

Location by Universal Transverse Mercator System: Zone 12N, 3935949 Northing, 473493 Easting

Figure 57.—Profile of Ives soil. Scale is in centimeters.

A—0 to 5 inches (0 to 12 centimeters); reddish brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; 25 percent clay; moderate medium angular blocky and platy structure; loose, very friable, slightly sticky, slightly plastic; few very fine and fine roots throughout; 10 percent gravel; violently effervescent, 15 percent calcium carbonate equivalent; slightly alkaline, pH 7.8; clear wavy boundary.

Cy—5 to 10 inches (12 to 24 centimeters); reddish brown (5YR 4/3) sandy loam, dark reddish brown (5YR 3/3) moist; 16 percent clay; moderate medium angular blocky and weak fine platy structure; loose, slightly sticky, slightly plastic; many very fine and fine roots throughout; common gypsum masses in matrix; 2 percent gravel;

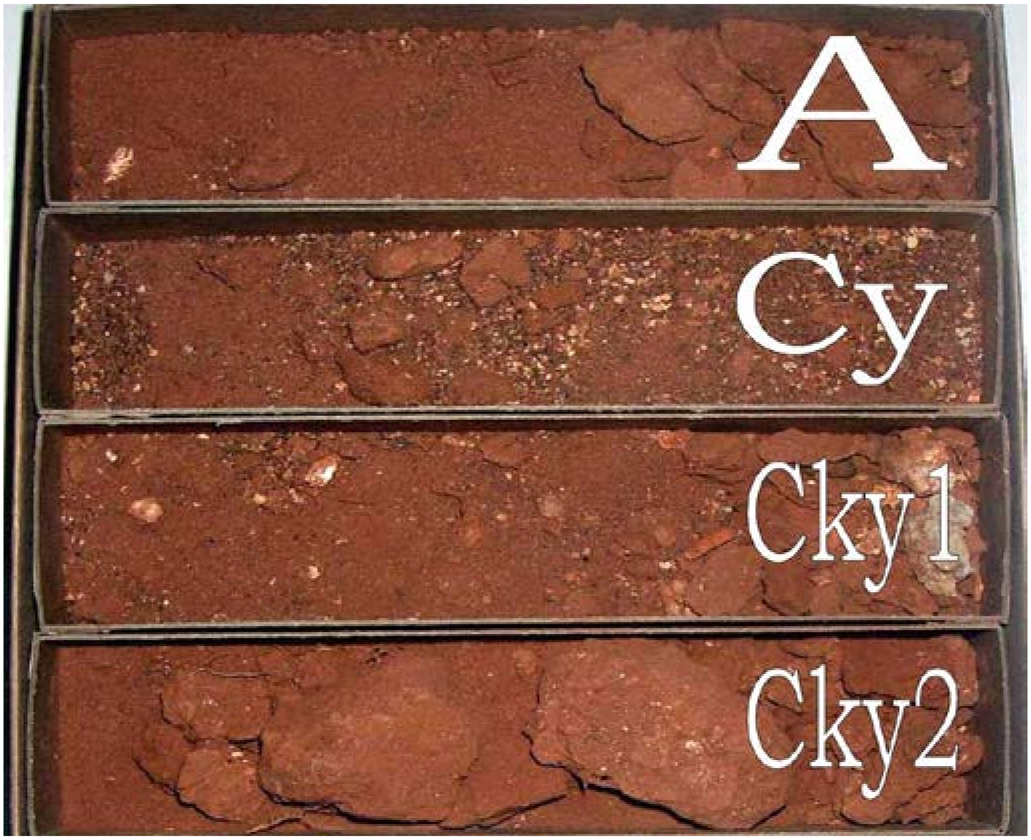


Figure 58.—Box sample of Ives typical pedon.

violently effervescent, 15 percent calcium carbonate equivalent and 2 percent gypsum; slightly alkaline, pH 7.6; abrupt smooth boundary.

Cky1—10 to 24 inches (24 to 61 centimeters); reddish brown (5YR 4/4) gravelly sandy loam, dark reddish brown (5YR 3/4) moist; 19 percent clay; moderate medium angular blocky structure; loose, slightly sticky, slightly plastic; few very fine and fine roots throughout; common medium and many very fine pores; finely disseminated carbonate and common gypsum masses in matrix; 25 percent gravel; violently effervescent, 15 percent calcium carbonate equivalent and 2 percent gypsum; slightly alkaline, pH 7.6; gradual wavy boundary.

Cky2—24 to 60 inches (61 to 152 centimeters); reddish brown (5YR 4/4) loamy sand, dark reddish brown (5YR 3/4) moist; 14 percent clay; massive; loose, slightly sticky, slightly plastic; many fine roots throughout; finely disseminated carbonate and common gypsum masses in matrix; 5 percent gravel; strongly effervescent, 12 percent calcium carbonate equivalent and 2 percent gypsum; slightly alkaline, pH 7.6.

Range in Characteristics

Rock fragment content of the control section: 0 to 30 percent
Clay content of particle-size control section: 8 to 18 percent

A horizon:
Hue—5YR or 7.5YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—sandy clay loam

Figure 59.—Surface sand fraction from Ives typical pedon.

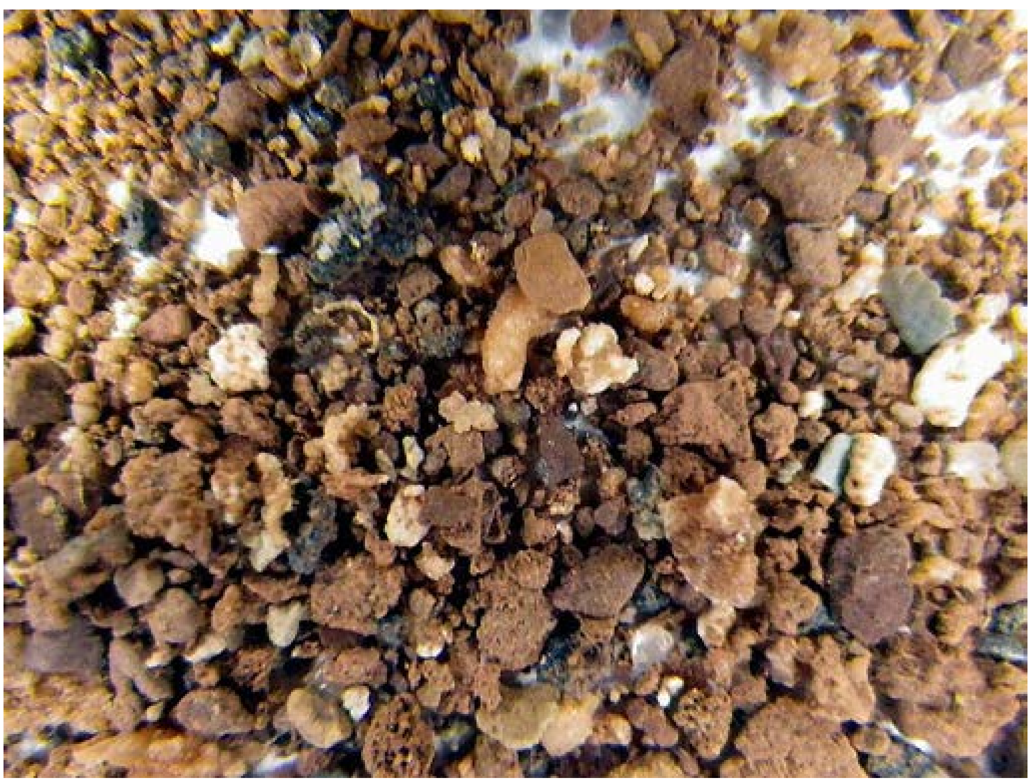


Figure 60.—Subsurface sand fraction from Ives typical pedon.

Clay content—20 to 28 percent
Calcium carbonate equivalent—10 to 25 percent
Rock fragments—0 to 30 percent
Reaction—slightly alkaline or moderately alkaline

Cy and Cky horizons:
Hue—5YR or 7.5YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—3 to 6, dry or moist
Texture—sandy loam, loamy sand, or fine sandy loam
Clay content—8 to 20 percent
Calcium carbonate equivalent—10 to 25 percent
Gypsum content—0 to 4 percent
Rock fragments—0 to 30 percent
Reaction—slightly alkaline or moderately alkaline

Description of Riverwash

Riverwash consists of unstabilized sandy, silty, clayey, or gravelly sediment that is flooded, washed, and reworked frequently by rivers and typically devoid of vegetation.

108—Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes

Map Unit Setting

Landform(s): Escarpments (figs. 61 and 62)
Elevation: 4,490 to 5,360 feet (1,368 to 1,635 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Meriwhitica and similar soils: 75 percent
Rock outcrop, limestone: 25 percent

Description of the Meriwhitica Soil

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents
Taxon kind: Series
Geomorphic position: Side slopes and footslopes resulting from normal faulting
Parent material: Residuum weathered from limestone
Elevation: 4,490 to 5,360 feet (1,368 to 1,635 meters)
Slope: 7 to 68 percent
Depth to restrictive feature(s): 4 to 20 inches to lithic bedrock
Drainage class: Excessively drained
K_{sat} in solum: 1.98 to 99.92 inches per hour (14.00 to 705.00 micrometers per second)
K_{sat} in restrictive layer: 0.00 to 0.06 inch per hour (0.00 to 0.42 micrometer per second)
Available water capacity (total inches): 0.6 (very low)
Shrink-swell potential: About 0.9 LEP (low)
Flooding hazard: None
Ponding hazard: None

Figure 61.—The Meriwhitica soil in an area of Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes.

Figure 62.—Rock outcrop in an area of Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes.

Figure 63.—Surface of Meriwhitica very gravelly loamy sand.

Runoff class: Medium
Hydrologic group: D
Ecological site name: Shallow Loamy 10-14” p.z.
Ecological site number: R035XA119AZ
Present vegetation: Black grama, Cutler’s jointfir, needle and thread, shadscale, alkali sacaton, oneseed juniper, rubber rabbitbrush, and Bigelow sage
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 63)

Canopy plant cover	24
Woody debris	2
Herbaceous litter	12
Bare soil	14
Gravel	30
Cobbles	15
Stones	15

Typical Pedon (figs. 64 through 67)

Location by Universal Transverse Mercator System: Zone 12N, 3937238 Northing, 466183 Easting

A—0 to 2 inches (0 to 5 centimeters); brown (7.5YR 5/4) very gravelly loamy sand, dark brown (7.5YR 3/4) moist; 10 percent clay; medium fine granular structure; loose, nonsticky, nonplastic; many very fine and common fine roots throughout; 35 percent gravel; strongly effervescent, 5 percent calcium carbonate equivalent; moderately alkaline, pH 8.0; clear smooth boundary.

Figure 64.—Profile of Meriwhitica soil. Scale is in centimeters (left) and inches (right).

C—2 to 7 inches (5 to 18 centimeters); brown (7.5YR 5/4) gravelly sandy loam, brown (7.5YR 4/4) moist; 12 percent clay; weak medium subangular blocky structure; soft, very friable, nonsticky, nonplastic; many very fine and common fine roots throughout; many very fine dendritic tubular pores; 20 percent gravel; violently effervescent, 15 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; clear wavy boundary.

Ck—7 to 11 inches (18 to 28 centimeters); brown (7.5YR 5/4) extremely gravelly loamy sand, dark brown (7.5YR 3/4) moist; 7 percent clay; massive; loose, nonsticky, nonplastic; common very fine roots throughout; common carbonate masses

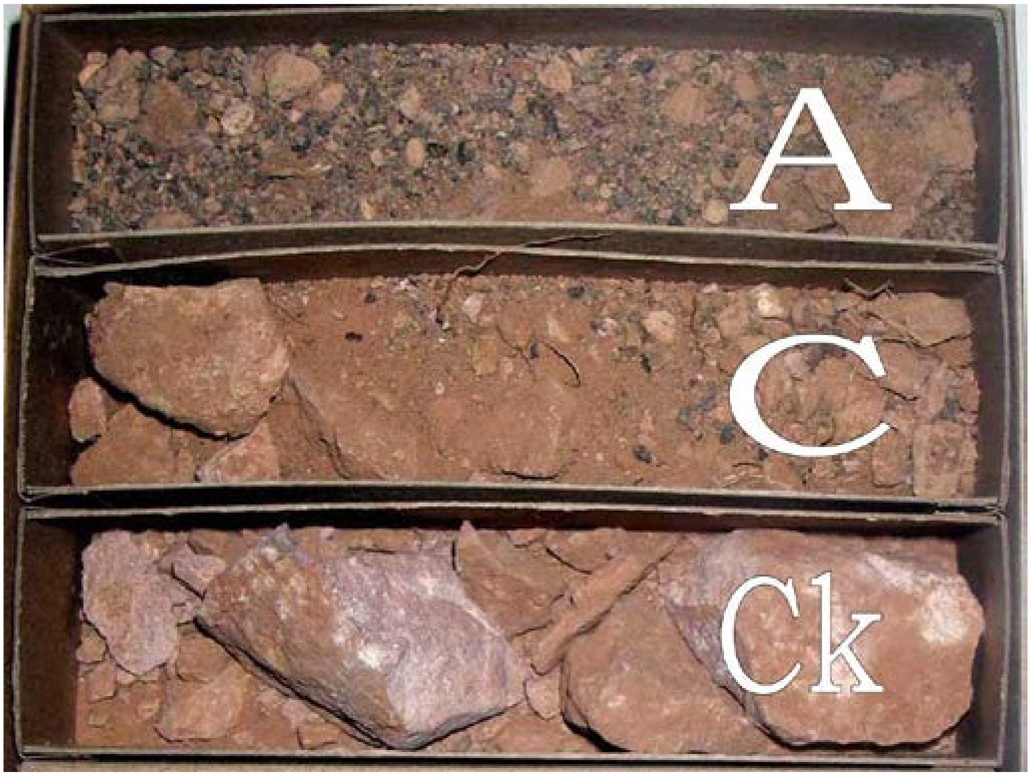


Figure 65.—Box sample of Meriwhitica typical pedon.

Figure 66.—Surface sand fraction from Meriwhitica typical pedon.

Figure 67.—Subsurface sand fraction from Meriwhitica typical pedon.

around rock fragments; 65 percent gravel; violently effervescent, 15 percent calcium carbonate equivalent; moderately alkaline, pH 8.2.

R—11 inches (28 centimeters); fractured, unweathered limestone.

Range in Characteristics

Rock fragment content of the control section: 35 to 75 percent
Clay content of particle-size control section: 5 to 15 percent

A horizon:
Hue—7.5YR or 10YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—loamy sand
Clay content—5 to 15 percent
Calcium carbonate equivalent—2 to 15 percent
Rock fragments—20 to 50 percent
Reaction—moderately alkaline

C or Ck horizon:
Hue—7.5YR or 10YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—sandy loam, loamy sand, or loam
Clay content—5 to 15 percent
Calcium carbonate equivalent—10 to 25 percent
Rock fragments—20 to 70 percent
Reaction—moderately alkaline

Figure 68.—An area of Miburn coarse sand, 1 to 10 percent slopes.

Description of Rock Outcrop, Limestone

The Rock outcrop consists of exposures of steep bedrock and cliffs. These areas are typically barren but may have sparse vegetation growing in cracks and crevices or in thin layers of eolian, alluvial, or colluvial material.

109—Miburn coarse sand, 1 to 10 percent slopes

Map Unit Setting

Landform(s): Dunes (fig. 68)
Elevation: 4,790 to 5,040 feet (1,459 to 1,536 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Miburn and similar soils: 85 percent
Minor components: Heiser soils—15 percent

Description of the Miburn, Tephra Soil

Taxonomic classification: Ashy over loamy, glassy over mixed, superactive, nonacid, mesic Vitrandic Torriorthents
Taxon kind: Series

Figure 69.—Surface of Miburn coarse sand.

Geomorphic position: Dips in ash dunes and toeslopes of climbing dunes
Parent material: Tephra derived from volcanic rock over alluvium derived from sedimentary rock
Elevation: 4,790 to 5,040 feet (1,459 to 1,536 meters)
Slope: 1 to 10 percent
Depth to restrictive feature(s): 7 to 20 inches to abrupt textural change
Drainage class: Somewhat excessively drained
K_{sat} *in solum:* 0.57 inch to 19.98 inches per hour (4.00 to 141.00 micrometers per second)
Available water capacity (total inches): 0.6 (very low)
Shrink-swell potential: About 1.0 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very low
Hydrologic group: B
Ecological site name: Loamy Upland 6-10” p.z.
Ecological site number: R035XB210AZ
Present vegetation: Torrey’s jointfir, buckwheat, Indian ricegrass, narrowleaf yucca, Apache plume, needle and thread, and sand bluestem
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 69)

Canopy plant cover	4
Woody debris	0
Herbaceous litter	2
Bare soil	0
Rock fragments (tephra)	10

Figure 70.—Profile of Miburn soil. Scale is in centimeters.

Typical Pedon (figs. 70 through 73)

Location by Universal Transverse Mercator System: Zone 12N, 3929924 Northing, 467278 Easting

C1—0 to 3 inches (0 to 7 centimeters); very dark gray (7.5YR 3/1) coarse sand, black (7.5YR 2.5/1) moist; 2 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; interstitial pores; noneffervescent; slightly alkaline, pH 7.6; gradual wavy boundary.

C2—3 to 10 inches (7 to 26 centimeters); very dark gray (7.5YR 3/1) fine sand, black (7.5YR 2.5/1) moist; 3 percent clay; single grain; loose, nonsticky, nonplastic; common medium and very fine roots throughout; interstitial pores; 10 percent cobbles; noneffervescent; slightly alkaline, pH 7.6; abrupt smooth boundary.

Figure 71.—Box sample of Miburn typical pedon.

2AB—10 to 23 inches (26 to 58 centimeters); brown (7.5YR 5/4) channery sandy loam, brown (7.5YR 4/4) moist; 12 percent clay; moderate medium subangular blocky structure; very hard, firm, slightly sticky, slightly plastic; common very fine roots throughout; many very fine vesicular pores; 5 percent gravel and 10 percent channers; violently effervescent, 5 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; gradual smooth boundary.

2Bk—23 to 45 inches (58 to 114 centimeters); brown (7.5YR 5/4) gravelly loamy sand, brown (7.5YR 4/4) moist; 6 percent clay; weak fine subangular blocky structure; hard, friable, nonsticky, nonplastic; common very fine roots throughout; common very fine dendritic tubular pores; common irregular carbonate masses; 15 percent gravel; violently effervescent, 5 percent calcium carbonate equivalent and 1 percent gypsum; strongly alkaline, pH 9.0; abrupt smooth boundary.

3C—45 to 60 inches (114 to 152 centimeters); brown (7.5YR 4/4) gravelly sandy loam, dark brown (7.5YR 3/4) moist; 11 percent clay; massive; few medium and very fine

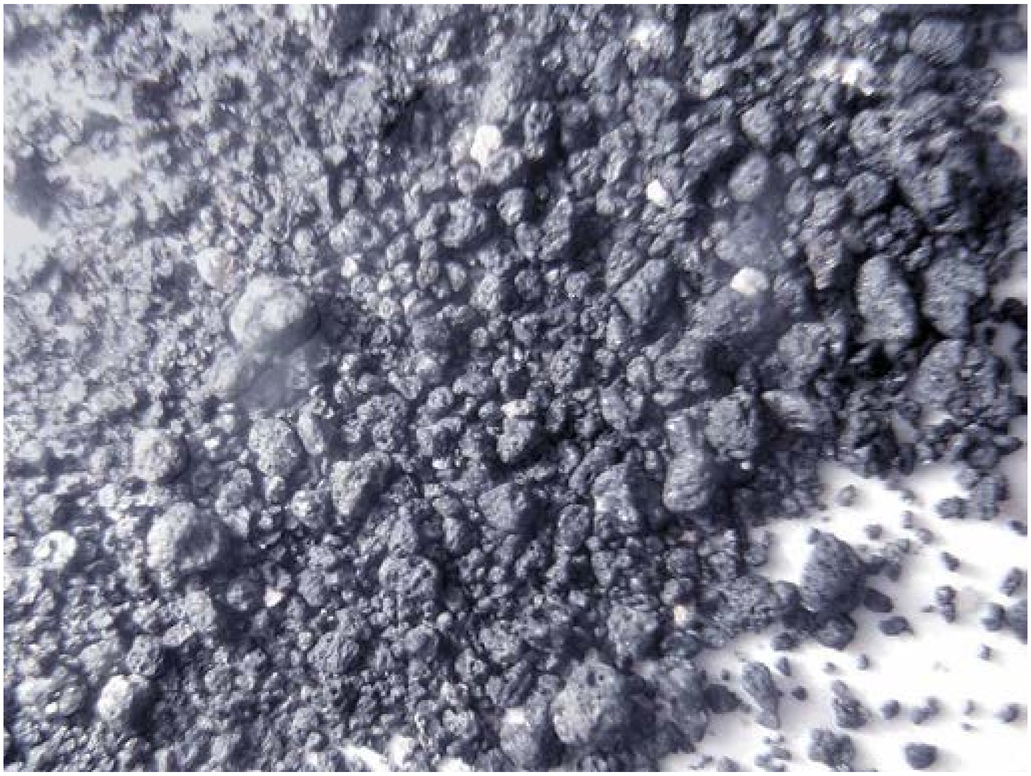


Figure 72.—Surface sand fraction from Miburn typical pedon.

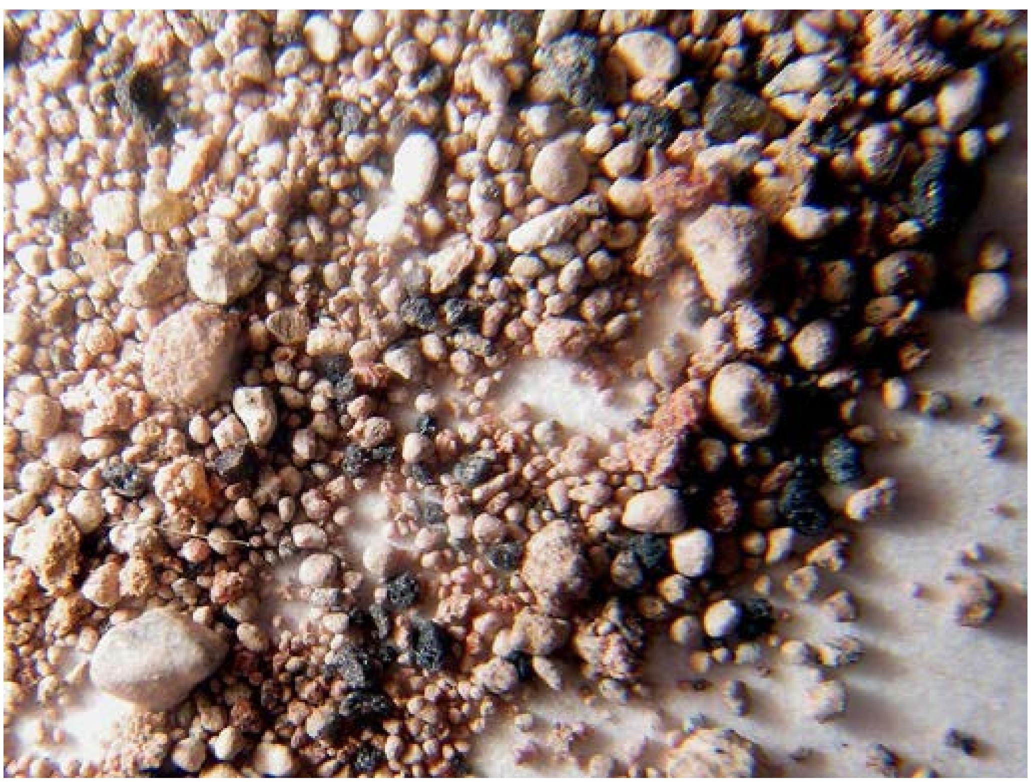


Figure 73.—Subsurface sand fraction from Miburn typical pedon.

roots throughout; 5 percent channers and 10 percent gravel; strongly effervescent, 5 percent calcium carbonate equivalent and 2 percent gypsum; strongly alkaline, pH 8.8.

Range in Characteristics

Rock fragment content of the control section: 0 to 30 percent cinders
Clay content of particle-size control section: Ashy section—1 to 5 percent; loamy section—10 to 13 percent
Volcanic glass content: 30 to 40 percent
Tephra cap: The zone from 0 to 10 inches (0 to 26 centimeters) (C horizons)
Abrupt textural change: The zone from 7 to 20 inches (18 to 51 centimeters) (C and AB horizons)

C horizons:
Hue—7.5YR or 10YR
Value—2.5 to 4 dry; 2.5 or 3 moist
Chroma—1 or 2, dry or moist
Texture—coarse sand or fine sand
Clay content—1 to 5 percent
Rock fragments—0 to 30 percent cinders
Reaction—slightly alkaline

2AB or 2Bk horizon:
Hue—7.5YR or 10YR
Value—4 to 6 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—sandy loam or loamy sand
Clay content—3 to 13 percent
Calcium carbonate equivalent—0 to 5 percent
Rock fragments—0 to 30 percent
Reaction—moderately alkaline or strongly alkaline

3C horizon:
Hue—5YR or 7.5YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—sandy loam
Clay content—3 to 11 percent
Calcium carbonate equivalent—0 to 5 percent
Rock fragments—15 to 30 percent
Reaction—moderately alkaline or strongly alkaline

110—Miburn-Cambidic Haplodurids complex, 1 to 8 percent slopes

Map Unit Setting

Landform(s): Dunes and terraces (figs. 74 and 75)
Elevation: 4,530 to 4,890 feet (1,381 to 1,490 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Figure 74.—The Miburn soil in an area of Miburn-Cambidic Haplodurids complex, 1 to 8 percent slopes.

Figure 75.—Cambidic Haplodurids in an area of Miburn-Cambidic Haplodurids complex, 1 to 8 percent slopes.

Figure 76.—Surface of Miburn coarse sand, in a gravelly area.

Map Unit Composition

Miburn and similar soils: 45 percent
Cambidic Haplodurids and similar soils: 40 percent
Minor components: Typic Haplocambids—10 percent; Heiser soils—5 percent

Description of the Miburn, Tephra Soil

Taxonomic classification: Ashy over loamy, glassy over mixed, superactive, nonacid, mesic Vitrandic Torriorthents
Taxon kind: Series
Geomorphic position: Dips in relict terrace deposits
Parent material: Tephra derived from volcanic rock over alluvium derived from igneous and sedimentary rock
Elevation: 4,530 to 4,890 feet (1,381 to 1,490 meters)
Slope: 1 to 8 percent
Depth to restrictive feature(s): 7 to 20 inches to abrupt textural change
Drainage class: Somewhat excessively drained
K_{sat} in solum: 0.57 inch to 19.98 inches per hour (4.00 to 141.00 micrometers per second)
Available water capacity (total inches): 0.5 (very low)
Shrink-swell potential: About 0.8 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Low
Hydrologic group: B
Ecological site name: Loamy Upland 6-10” p.z.
Ecological site number: R035XB210AZ
Present vegetation: Galleta, rubber rabbitbrush, globemallow, Indian ricegrass, oneseed juniper, forbs, and annuals

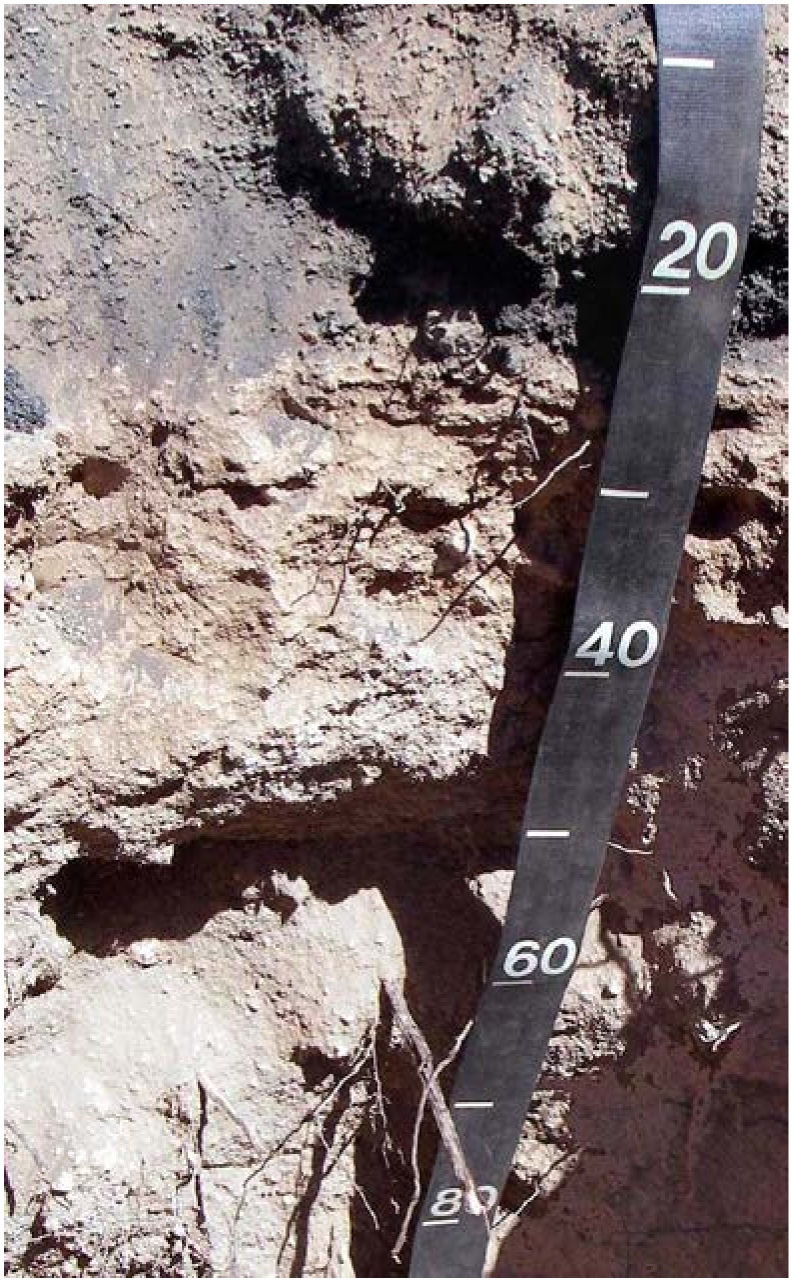


Figure 77.—Profile of Miburn soil. Scale is in centimeters.

Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 76)

Canopy plant cover	38
Woody debris	0
Herbaceous litter	10
Bare soil	4
Rock fragments (tephra)	15

Typical Pedon (figs. 77 through 80)

Location by Universal Transverse Mercator System: Zone 12N, 3933533 Northing, 467086 Easting

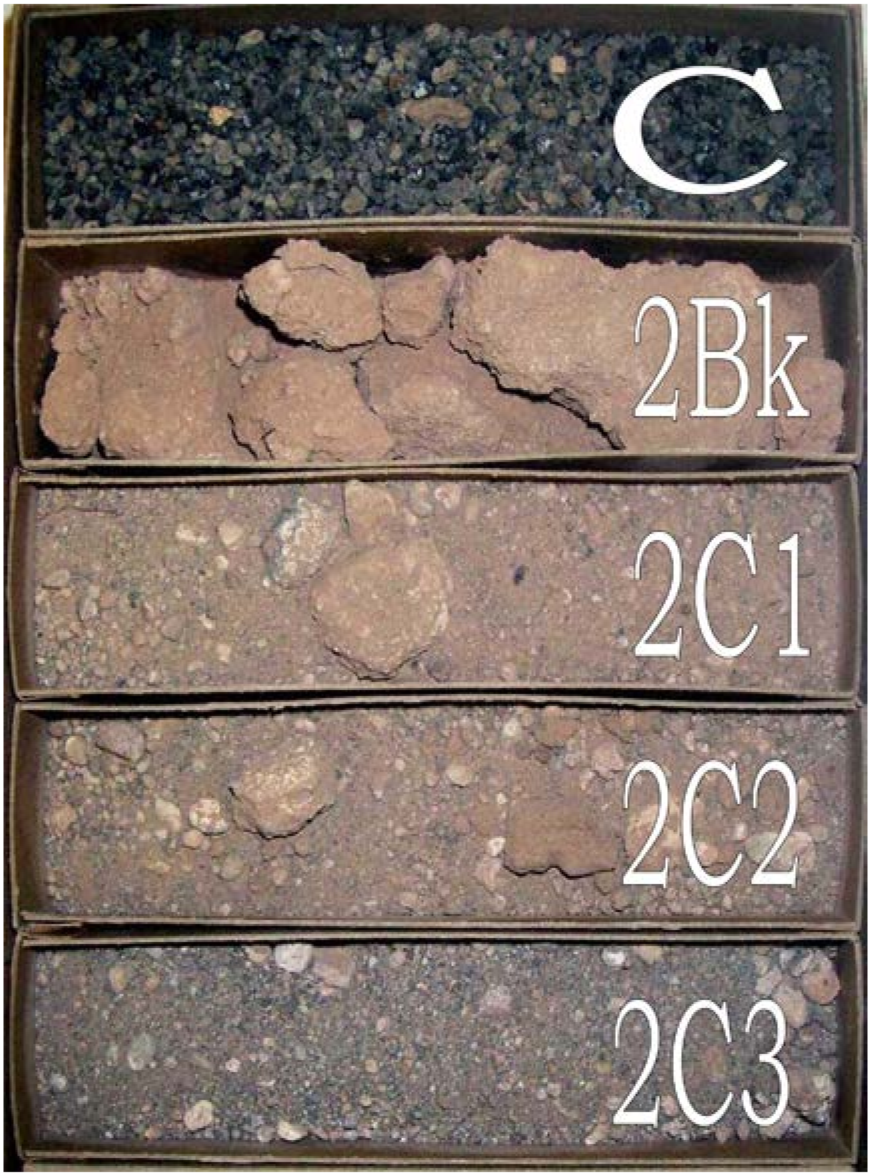


Figure 78.—Box sample of Miburn typical pedon.

C—0 to 10 inches (0 to 26 centimeters); very dark gray (7.5YR 3/1) coarse sand, black (7.5YR 2.5/1) moist; 3 percent clay; single grain; loose, nonsticky, nonplastic; many very fine roots throughout; noneffervescent; slightly alkaline, pH 7.6; abrupt wavy boundary.

2Bk—10 to 15 inches (26 to 37 centimeters); brown (10YR 5/3) gravelly sandy loam, brown (10YR 4/3) moist; 11 percent clay; weak thin platy structure; moderately hard, friable, slightly sticky, nonplastic; common very fine and fine roots; dendritic tubular pores; common spherical carbonate masses; 20 percent gravel; strongly effervescent, 5 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; clear smooth boundary.

2C1—15 to 28 inches (37 to 71 centimeters); brown (10YR 5/3) gravelly loamy sand, brown (10YR 4/3) moist; 6 percent clay; massive; loose, nonsticky, nonplastic; few medium and coarse and common very fine roots throughout; 25 percent gravel; strongly effervescent; strongly alkaline, pH 8.6; clear smooth boundary.

Figure 79.—Surface sand fraction from Miburn typical pedon.

Figure 80.—Subsurface sand fraction from Miburn typical pedon.

2C2—28 to 46 inches (71 to 117 centimeters); brown (10YR 5/3) very cobbly loamy sand, brown (10YR 4/3) moist; 5 percent clay; massive; loose, nonsticky, nonplastic; few medium and common very fine and fine roots throughout; 20 percent cobbles and 20 percent gravel; strongly effervescent; strongly alkaline, pH 8.6; gradual smooth boundary.

2C3—46 to 60 inches (117 to 152 centimeters); grayish brown (10YR 5/2) gravelly sand, brown (10YR 4/3) moist; 5 percent clay; massive; loose, nonsticky, nonplastic; 15 percent gravel; strongly effervescent; strongly alkaline, pH 8.6.

Range in Characteristics

Rock fragment content of the control section: 0 to 30 percent
Clay content of particle-size control section: Ashy section—1 to 4 percent; loamy section—8 to 14 percent
Volcanic glass content: 30 to 40 percent
Tephra cap: The zone from 0 to 10 inches (0 to 26 centimeters) (C horizon)
Abrupt textural change: The zone from 7 to 15 inches (18 to 37 centimeters) (C and 2Bk horizons)

C horizon:
Hue—7.5YR or 10YR
Value—2.5 to 4 dry; 2.5 or 3 moist
Chroma—1 or 2, dry or moist
Texture—coarse sand
Clay content—1 to 4 percent
Rock fragments—0 to 5 percent cinders
Reaction—slightly alkaline or moderately alkaline

2Bk or 2C horizons:
Hue—7.5YR or 10YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—2 or 3, dry or moist
Texture—sandy loam, loamy sand, or sand
Clay content—3 to 14 percent
Carbonate equivalent—0 to 10 percent
Rock fragments—10 to 50 percent
Reaction—moderately alkaline or strongly alkaline

Description of the Cambidic Haplodurids

Taxonomic classification: Sandy, mixed, mesic Cambidic Haplodurids
Taxon kind: Taxon above family
Geomorphic position: Rises in relict terrace deposits
Parent material: Alluvium derived from igneous and sedimentary rock
Elevation: 4,530 to 4,890 feet (1,381 to 1,490 meters)
Slope: 1 to 8 percent
Depth to restrictive feature(s): 7 to 20 inches to duripan
Drainage class: Excessively drained
K_{sat} *in solum:* 0.00 to 19.98 inches per hour (0.01 micrometer to 141.00 micrometers per second)
Available water capacity (total inches): 3.1 (low)
Shrink-swell potential: About 0.8 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very high
Hydrologic group: D
Ecological site name: Loamy Upland 6-10” p.z.

Figure 81.—Surface of Cambidic Haplodurids, loamy sand.

Ecological site number: R035XB210AZ
Present vegetation: Galleta, black grama, rubber rabbitbrush, Apache plume, globemallow, Indian ricegrass, oneseed juniper, Phacelia, Torrey's jointfir, and fleabane
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 81)

Canopy plant cover	30
Woody debris	0
Herbaceous litter	4
Bare soil	4
Rock fragments (cinders)	15

Typical Pedon (figs. 82 through 85)

Location by Universal Transverse Mercator System: Zone 12N, 3933769 Northing, 466976 Easting

C—0 to 7 inches (0 to 18 centimeters); dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; 9 percent clay; single grain; loose, slightly sticky, nonplastic; common very fine and fine roots throughout; fine irregular pores; noneffervescent; moderately alkaline, pH 8.2; abrupt smooth boundary.

2Bkq—7 to 18 inches (18 to 44 centimeters); light brown (7.5YR 6/4) loamy sand, brown (7.5YR 5/4) moist; 5 percent clay; massive; extremely hard, very firm, slightly sticky, nonplastic; few very fine and fine roots throughout; common very fine vesicular pores; many irregular very strongly cemented silica concretions around rock fragments and many irregular very strongly cemented carbonate concretions around rock fragments; 2 percent gravel; slightly effervescent, 2

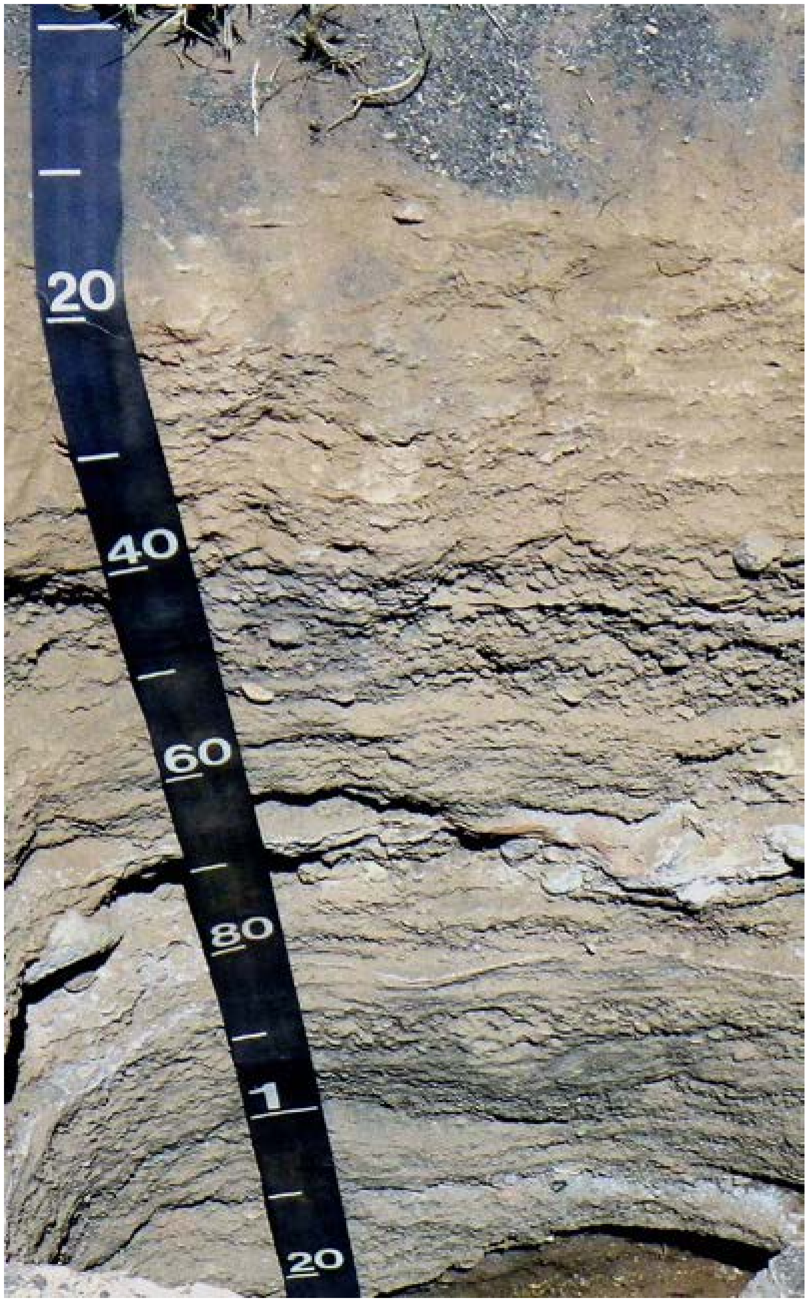


Figure 82.—Profile of Cambidic Haplodurids. Scale is in centimeters

percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt wavy boundary.

2Bkqm—18 to 31 inches (44 to 79 centimeters); brown (10YR 5/3) loamy sand, brown (10YR 4/3) moist; moderately cemented duripan; abrupt wavy boundary.

2Bqm1—31 to 42 inches (79 to 107 centimeters); grayish brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) moist; moderately cemented duripan; abrupt wavy boundary.

2Bqm2—42 to 60 inches (107 to 152 centimeters); dark grayish brown (10YR 4/2) loamy sand, very dark grayish brown (10YR 3/2) moist; moderately cemented duripan.

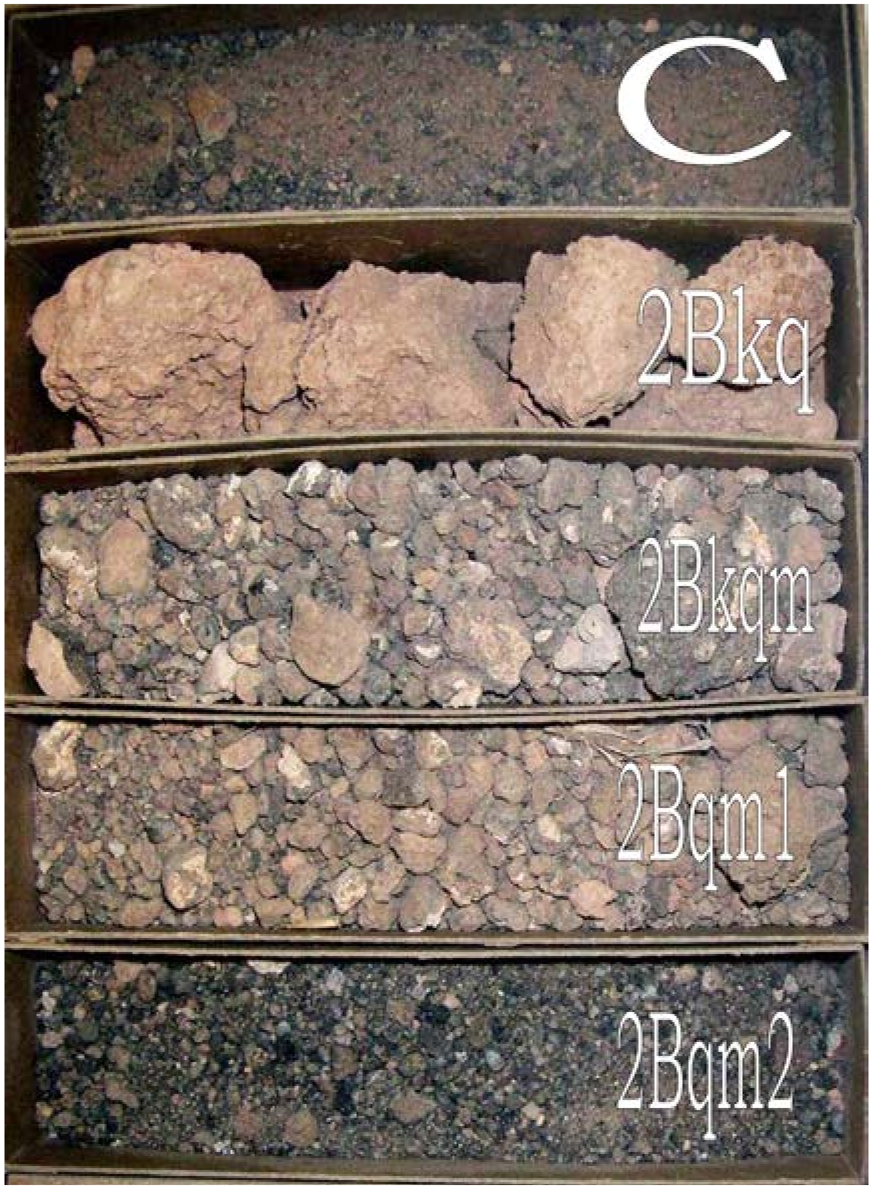


Figure 83.—Box sample of Cambidic Haplodurids typical pedon.

Note: Table 31 shows lab data for this pedon.

Range in Characteristics

Note: Cambidic Haplodurids have soil properties that vary beyond family class limits.

Rock fragment content of the control section: 0 to 30 percent
Clay content of particle-size control section: 3 to 8 percent
Duripan: The zone from 18 to 60 inches (44 to 152 centimeters) (Bkqm and Bqm horizons)

C horizon:
Hue—7.5YR or 10YR
Value—2.5 to 4 dry; 2.5 or 3 moist
Chroma—1 or 2, dry or moist
Texture—loamy sand or coarse sand

Figure 84.—Surface sand fraction from Cambidic Haplodurids typical pedon.

Figure 85.—Subsurface sand fraction from Cambidic Haplodurids typical pedon.

Figure 86.—The Miburn soil in an area of Miburn-Heiser-Lava flows complex, 4 to 45 percent slopes.

Clay content—2 to 10 percent
Rock fragments—0 to 40 percent cinders
Reaction—moderately alkaline

Bkq horizon:
Hue—7.5YR or 10YR
Value—4 to 6 dry; 3 to 5 moist
Chroma—2 to 4, dry or moist
Texture—coarse sand or loamy sand
Clay content—3 to 8 percent
Calcium carbonate equivalent—0 to 10 percent
Rock fragments—0 to 40 percent cinders
Reaction—moderately alkaline or strongly alkaline

Bkqm and Bqm horizons:
Cementation—silica
Thickness—42 to 48 inches
Hardness—moderately cemented or strongly cemented

111—Miburn-Heiser-Lava flows complex, 4 to 45 percent slopes

Map Unit Setting

Landform(s): Climbing dunes, escarpments, and lava flows (figs. 86, 87, and 88)
Elevation: 4,560 to 5,240 feet (1,390 to 1,597 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Figure 87.—The Heiser soil in an area of Miburn-Heiser-Lava flows complex, 4 to 45 percent slopes.

Figure 88.—Lava flows in an area of Miburn-Heiser-Lava flows complex, 4 to 45 percent slopes.

Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Miburn and similar soils: 50 percent
Heiser and similar soils: 35 percent
Lava flows, basalt: 10 percent
Minor components: Nalakihu, dry soils—5 percent

Description of the Miburn, Tephra Soil

Taxonomic classification: Ashy over loamy, glassy over mixed, superactive, nonacid, mesic Vitrandic Torriorthents
Taxon kind: Family
Geomorphic position: Footslopes and toeslopes on top of relict dunes
Parent material: Tephra derived from volcanic rock over eolian sands
Elevation: 4,560 to 5,240 feet (1,390 to 1,597 meters)
Slope: 4 to 45 percent
Depth to restrictive feature(s): 7 to 16 inches to abrupt textural change; 20 to 40 inches to lithic bedrock
Drainage class: Somewhat excessively drained
K_{sat} *in solum:* 0.57 inch to 19.98 inches per hour (4.00 to 141.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.01 inch to 20.00 inches per hour (0.07 micrometer to 141.14 micrometers per second)
Available water capacity (total inches): 0.3 (very low)
Shrink-swell potential: About 1.3 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: High
Hydrologic group: C
Ecological site name: Loamy Upland 6-10” p.z.
Ecological site number: R035XB210AZ
Present vegetation: Buckwheat, rubber rabbitbrush, Torrey’s jointfir, sand sagebrush, Indian ricegrass, James’ galleta, oneseed juniper, and threeawn
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 89)

Canopy plant cover	18
Woody debris	0
Herbaceous litter	4
Bare soil	2
Rock fragments (tephra)	5

Typical Pedon (figs. 90 through 93)

Location by Universal Transverse Mercator System: Zone 12N, 3929276 Northing, 466862 Easting

C1—0 to 4 inches (0 to 10 centimeters); very dark gray (7.5YR 3/1) channery coarse sand, black (7.5YR 2.5/1) moist; 4 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; interstitial pores; 5 percent volcanic bombs and 10 percent cinders; noneffervescent; slightly alkaline, pH 7.8; abrupt smooth boundary.

Figure 89.—Surface of Miburn channery coarse sand.

C2—4 to 7 inches (10 to 18 centimeters); very dark gray (7.5YR 3/1) coarse sand, black (7.5YR 2.5/1) moist; 2 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; interstitial pores; noneffervescent; moderately alkaline, pH 8.0; abrupt smooth boundary.

2Bk—7 to 22 inches (18 to 56 centimeters); reddish brown (5YR 5/4) gravelly sandy loam, reddish brown (5YR 4/4) moist; 15 percent clay; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few medium and common very fine roots throughout; common dendritic tubular pores; 5 percent cobbles and 10 percent gravel; violently effervescent, 10 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt smooth boundary.

3R—22 inches (56 centimeters); fractured, unweathered basalt.

Range in Characteristics

Note: Because this Miburn soil is moderately deep to lithic bedrock, whereas the Miburn series is very deep, it is mapped as a family to the series.

Rock fragment content of the control section: 15 to 30 percent
Clay content of particle-size control section: Ashy section—1 to 6 percent; loamy section—8 to 17 percent
Volcanic glass content: 30 to 40 percent
Tephra cap: The zone from 0 to 7 inches (0 to 18 centimeters) (C horizons)
Abrupt textural change: The zone from 7 to 20 inches (18 to 51 centimeters) (C and 2Bk horizons)

C horizons:
Hue—7.5YR or 10YR
Value—2.5 or 3 dry; 2.5 moist

Figure 90.—Profile of Miburn soil. Scale is in centimeters.

Chroma—1 or 2, dry or moist
Texture—coarse sand, sand, or fine sand
Clay content—1 to 6 percent
Rock fragments—0 to 30 percent cinders
Reaction—neutral to moderately alkaline

2Bk horizon:
Hue—5YR or 7.5YR
Value—3 to 5 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—fine sandy loam, sandy clay loam, or sandy loam
Clay content—8 to 17 percent
Calcium carbonate equivalent—10 to 25 percent

Figure 91.—Box sample of Miburn typical pedon.

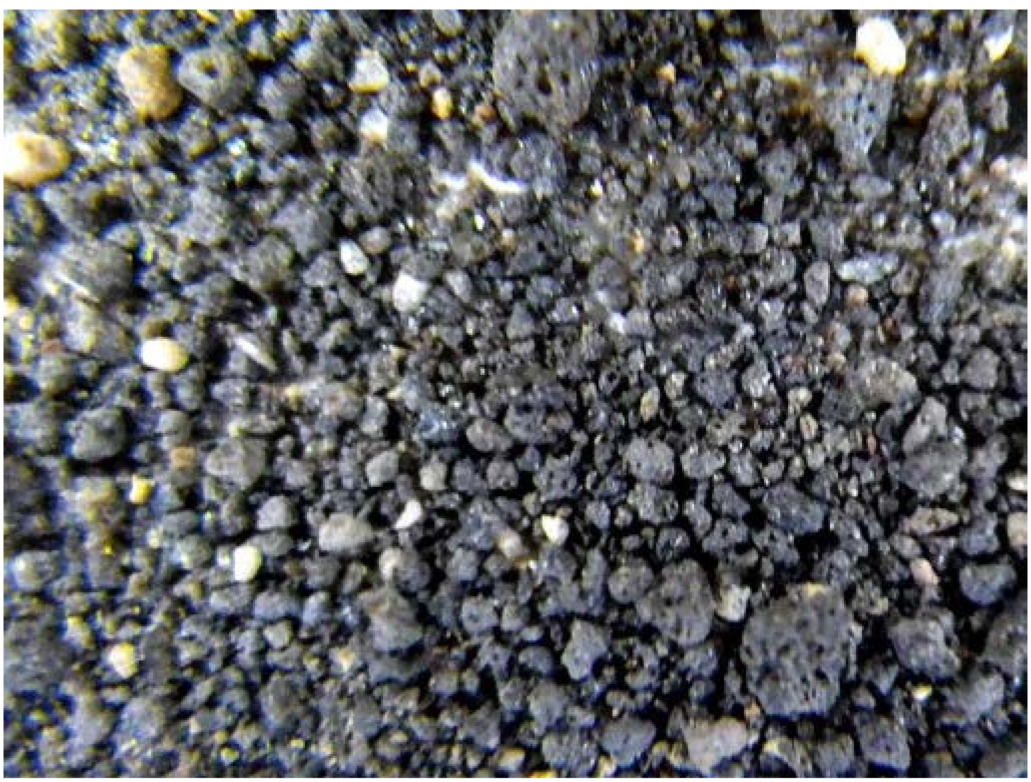


Figure 92.—Surface sand fraction from Miburn typical pedon.

Figure 93.—Subsurface sand fraction from Miburn typical pedon.

Rock fragments—15 to 30 percent
Reaction—slightly alkaline to strongly alkaline

Description of the Heiser Soil

Taxonomic classification: Ashy, glassy, nonacid, mesic Vitrandic Torripsamments
Taxon kind: Series
Geomorphic position: Side slopes and footslopes
Parent material: Tephra derived from volcanic rock
Elevation: 4,560 to 5,240 feet (1,390 to 1,597 meters)
Slope: 4 to 45 percent
Drainage class: Excessively drained
K_{sat} *in solum:* 5.95 to 19.98 inches per hour (42.00 to 141.00 micrometers per second)
Available water capacity (total inches): 3.0 (low)
Shrink-swell potential: About 0.2 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very low
Hydrologic group: A
Ecological site name: Loamy Upland 6-10” p.z.
Ecological site number: R035XB210AZ
Present vegetation: Rubber rabbitbrush, buckwheat, Indian ricegrass, Torrey’s jointfir, and threeawn
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 94)

Canopy plant cover	14
Woody debris	0

Figure 94.—Surface of Heiser gravelly coarse sand.

Herbaceous litter	12
Bare soil	0
Rock fragments (tephra)	10

Typical Pedon (figs. 95 through 98)

Location by Universal Transverse Mercator System: Zone 12N, 3929200 Northing, 466753 Easting

C1—0 to 2 inches (0 to 5 centimeters); very dark gray (7.5YR 3/1) gravelly coarse sand, black (7.5YR 2.5/1) moist; 4 percent clay; single grain; loose, nonsticky, nonplastic; few very fine roots throughout; interstitial pores; 20 percent cinders; noneffervescent; neutral, pH 7.2; abrupt smooth boundary.

C2—2 to 60 inches (5 to 152 centimeters); very dark gray (7.5YR 3/1) coarse sand, black (7.5YR 2.5/1) moist; 2 percent clay; massive; loose, nonsticky, nonplastic; few medium and common very fine roots throughout; noneffervescent; slightly alkaline, pH 7.6.

Range in Characteristics

Rock fragment content of the control section: 0 to 25 percent cinders
Clay content of particle-size control section: 2 to 6 percent
Volcanic glass content: 30 to 40 percent

C horizons:
Hue—7.5YR or 10YR
Value—2.5 to 3 dry; 2.5 moist
Chroma—1 to 2, dry or moist
Texture—coarse sand, sand, or fine sand

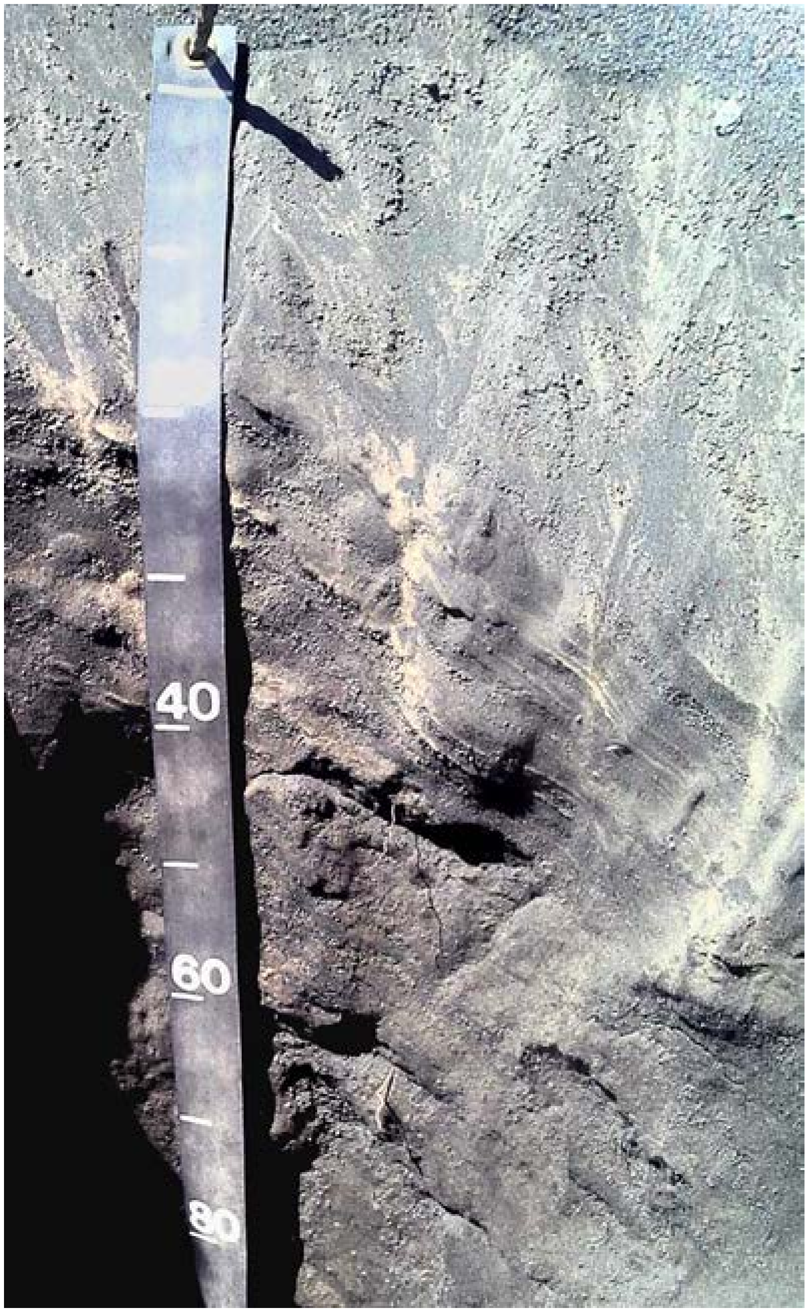


Figure 95.—Profile of Heiser soil. Scale is in centimeters.

Clay content—1 to 6 percent
Rock fragments—0 to 30 percent cinders
Reaction—neutral to moderately alkaline

Description of Lava Flows, Basalt

Lava flows typically have weathered surfaces, crevices, and angular blocks that are characteristic of Pleistocene Epoch lava flows. Earthy material has accumulated in rocks and sheltered pockets, but the flows are virtually devoid of vegetation with the exception of lichens.

Figure 96.—Box sample of Heiser typical pedon.

Figure 97.—Surface sand fraction from Heiser typical pedon.

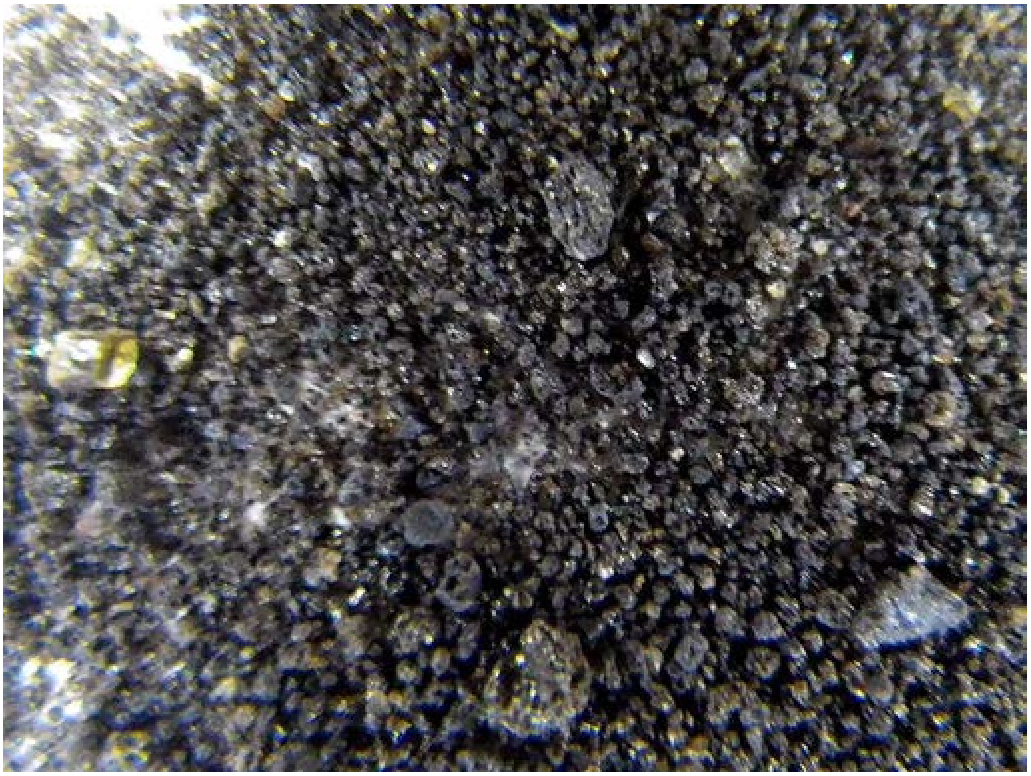


Figure 98.—Subsurface sand fraction from Heiser typical pedon.

112—Moenkopie-Typic Haplocambids complex, 1 to 6 percent slopes

Map Unit Setting

Landform(s): Structural benches (figs. 99 and 100)
Elevation: 4,390 to 4,980 feet (1,339 to 1,517 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Moenkopie and similar soils: 45 percent
Typic Haplocambids and similar soils: 40 percent
Minor components: Lithic Torripsamments—10 percent; Bighawk soils—5 percent

Description of the Moenkopie Soil

Taxonomic classification: Loamy, mixed, superactive, calcareous, mesic Lithic Torriorthents
Taxon kind: Series

Figure 99.—The Moenkopie soil in an area of Moenkopie-Typic Haplocambids complex, 1 to 6 percent slopes.

Figure 100.—Typic Haplocambids in an area of Moenkopie-Typic Haplocambids complex, 1 to 6 percent slopes.

Figure 101.—Surface of Moenkopie very channery sandy clay loam.

Geomorphic position: Barren rises between elongated toeslopes of ash dunes
Parent material: Residuum weathered from sandstone and shale
Elevation: 4,390 to 4,980 feet (1,339 to 1,517 meters)
Slope: 1 to 6 percent
Depth to restrictive feature(s): 3 to 20 inches to lithic bedrock
Drainage class: Well drained
K_{sat} *in solum:* 0.20 to 0.57 inch per hour (1.40 to 4.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.20 inch per hour (0.00 to 1.41 micrometers per second)
Available water capacity (total inches): 0.4 (very low)
Shrink-swell potential: About 2.8 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very high
Hydrologic group: D
Ecological site name: Sandstone/Shale Upland 6-10” p.z.
Ecological site number: R035XB215AZ
Present vegetation: Torrey’s jointfir, fourwing saltbush, bush muhly, broom snakeweed, fluffgrass, and globemallow
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 101)

Canopy plant cover	14
Woody debris	0
Herbaceous litter	8
Bare soil	14
Rock fragments (tephra)	70

Figure 102.—Profile of Moenkopie soil. Scale is in inches (left) and centimeters (right).

Typical Pedon (figs. 102 through 105)

Location by Universal Transverse Mercator System: Zone 12N, 3930507 Northing, 467152 Easting

A—0 to 2 inches (0 to 4 centimeters); light yellowish brown (10YR 6/4) very channery sandy clay loam, yellowish brown (10YR 5/4) moist; 22 percent clay; moderate thin platy structure; slightly hard, friable, slightly sticky, slightly plastic; many very fine vesicular pores; 10 percent gravel, 10 percent flagstones, and 25 percent channers; strongly effervescent, 10 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt smooth boundary.

C—2 to 4 inches (4 to 9 centimeters); light yellowish brown (10YR 6/4) channery sandy clay loam, yellowish brown (10YR 5/4) moist; 26 percent clay; moderate thin platy structure; moderately hard, friable, moderately sticky, moderately plastic; many very fine vesicular pores; 15 percent channers; violently effervescent, 15 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt smooth boundary.

R—4 inches (9 centimeters); fractured, unweathered sandstone.

Range in Characteristics

Rock fragment content of the control section: 15 to 35 percent
Clay content of particle-size control section: 17 to 27 percent

A horizon:
Hue—5YR or 10YR
Value—4 to 6 dry; 4 or 5 moist
Chroma—3 or 4, dry or moist
Texture—sandy clay loam
Clay content—17 to 27 percent

Figure 103.—Box sample of Moenkopie typical pedon.

Figure 104.—Surface sand fraction from Moenkopie typical pedon.

Calcium carbonate equivalent—10 to 15 percent
Rock fragments—15 to 60 percent
Reaction—moderately alkaline or strongly alkaline

C horizon:
Hue—5YR or 10YR
Value—4 to 6 dry; 4 or 5 moist
Chroma—4 to 6, dry or moist

Figure 105.—Subsurface sand fraction from Moenkopie typical pedon.

Texture—sandy clay loam or sandy loam
Clay content—17 to 27 percent
Calcium carbonate equivalent—10 to 25 percent
Rock fragments—15 to 60 percent
Reaction—moderately alkaline or strongly alkaline

Description of Typic Haplocambids, Tephra

Taxonomic classification: Coarse-loamy, mixed, superactive, mesic Typic Haplocambids
Taxon kind: Taxon above family
Geomorphic position: Dips on top of elongated toeslopes of ash dunes
Parent material: Residuum weathered from sandstone and shale
Elevation: 4,390 to 4,980 feet (1,339 to 1,517 meters)
Slope: 1 to 6 percent
Depth to restrictive feature(s): 40 to 60 inches to lithic bedrock
Drainage class: Somewhat excessively drained
K_{sat} *in solum:* 0.57 inch to 19.98 inches per hour (4.00 to 141.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.20 inch to 2.00 inches per hour (1.41 to 14.11 micrometers per second)
Available water capacity (total inches): 2.5 (very low)
Shrink-swell potential: About 1.1 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Negligible
Hydrologic group: B

Figure 106.—Surface of Typic Haplocambids, gravelly loamy sand.

Ecological site name: Loamy Upland 6-10” p.z.
Ecological site number: R035XB210AZ
Present vegetation: Torrey’s jointfir, fourwing saltbush, broom snakeweed, rubber rabbitbrush, bush muhly, sand sagebrush, globemallow, and Indian ricegrass
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 106)

Canopy plant cover	28
Woody debris	2
Herbaceous litter	26
Bare soil	48
Rock fragments (tephra)	5

Typical Pedon (figs. 107 through 110)

Location by Universal Transverse Mercator System: Zone 12N, 3930462 Northing, 467186 Easting

C—0 to 3 inches (0 to 7 centimeters); dark grayish brown (10YR 4/2) gravelly loamy sand, very dark grayish brown (10YR 3/2) moist; 6 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; interstitial pores; 15 percent cinders; noneffervescent; moderately alkaline, pH 8.0; abrupt wavy boundary.

2Bw1—3 to 10 inches (7 to 24 centimeters); brown (7.5YR 4/4) gravelly sandy loam, dark brown (7.5YR 3/3) moist; 12 percent clay; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few medium and many very fine roots throughout; common very fine irregular pores; 25 percent gravel; strongly effervescent, 10 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; abrupt wavy boundary.

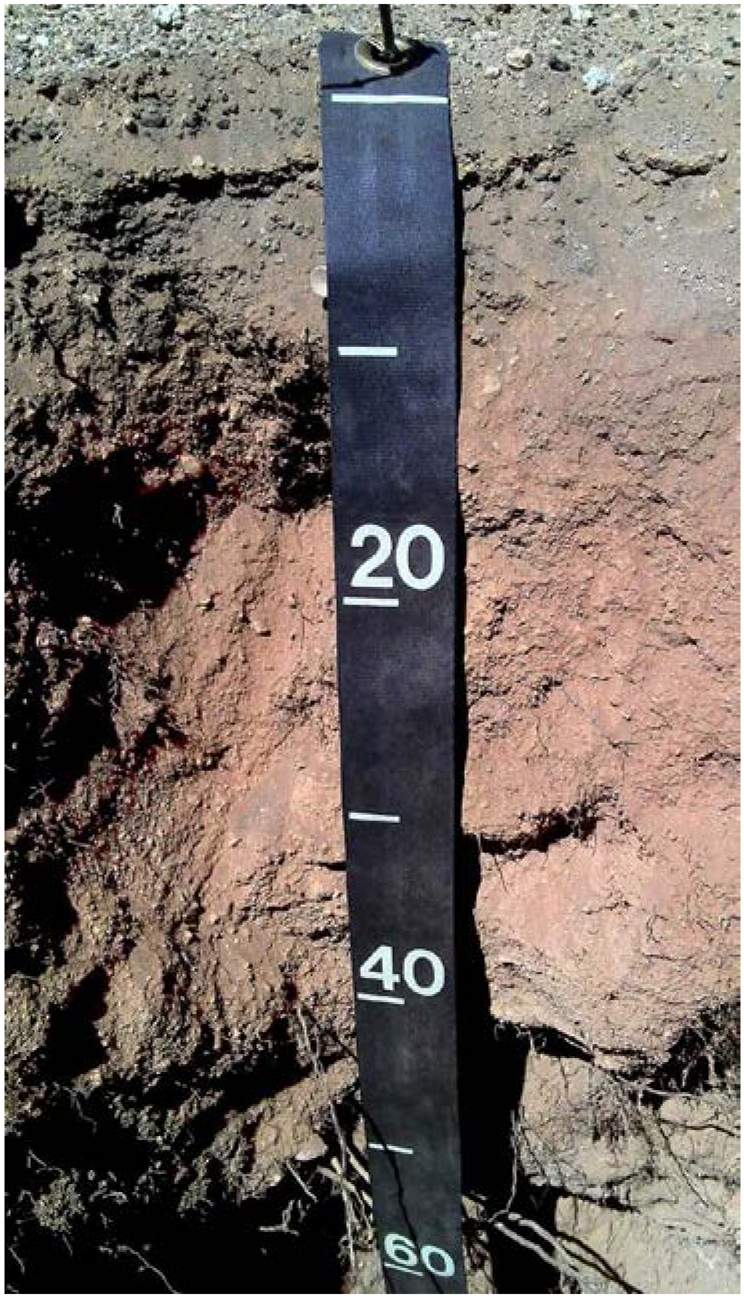


Figure 107.—Profile of Typic Haplocambids. Scale is in centimeters.

2Bw2—10 to 17 inches (24 to 42 centimeters); brown (7.5YR 4/4) gravelly sandy loam, dark brown (7.5YR 3/3) moist; 14 percent clay; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; many fine and few medium roots throughout; common very fine dendritic tubular pores; 20 percent gravel; violently effervescent, 15 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; gradual wavy boundary.

2C1—17 to 32 inches (42 to 80 centimeters); dark grayish brown (10YR 4/2) gravelly loamy sand, very dark grayish olive (10Y 3/2) moist; 6 percent clay; weak fine subangular blocky structure; soft, very friable, nonsticky, nonplastic; common medium and many very fine roots throughout; interstitial pores; 5 percent channers

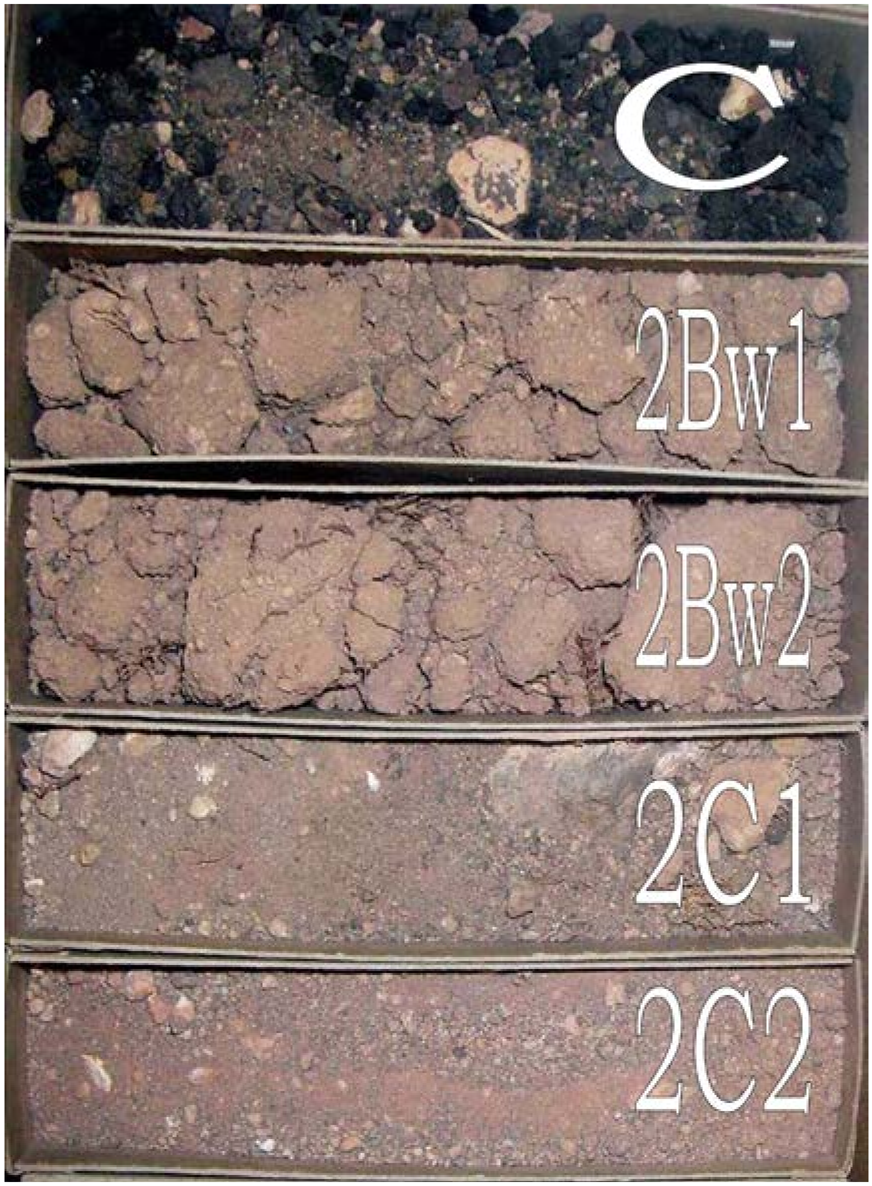


Figure 108.—Box sample of Typic Haplocambids typical pedon.

and 10 percent gravel; strongly effervescent, 10 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; gradual wavy boundary.

2C2—32 to 42 inches (80 to 107 centimeters); brown (7.5YR 5/3) gravelly loamy sand, brown (7.5YR 4/3) moist; 8 percent clay; massive; soft, very friable, nonsticky, nonplastic; common very fine roots throughout; interstitial pores; 5 percent cobbles and 20 percent gravel; violently effervescent, 15 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; gradual wavy boundary.

2R—42 inches (107 centimeters); fractured, unweathered sandstone.

Range in Characteristics

Rock fragment content of the control section: 5 to 35 percent
Clay content of particle-size control section: 4 to 18 percent
Tephra cap: The zone from 0 to 3 inches (0 to 7 centimeters) (C horizon)
Cambic horizon: The zone from 3 to 17 inches (7 to 42 centimeters) (Bw horizons)

Figure 109.—Surface sand fraction from Typic Haplocambids typical pedon.

Figure 110.—Subsurface sand fraction from Typic Haplocambids typical pedon.

C horizon:
Hue—5YR, 7.5YR, or 10YR
Value—2.5 to 4 dry; 2.5 or 3 moist
Chroma—1 or 2, dry or moist
Texture—loamy sand
Clay content—4 to 10 percent
Rock fragments—5 to 35 percent cinders
Reaction—moderately alkaline

2Bw horizons:
Hue—5YR or 7.5YR
Value—4 to 7 dry; 3 to 5 moist
Chroma—2 to 4, dry or moist
Texture—loamy sand, sandy loam, or coarse sandy loam
Clay content—8 to 18 percent
Calcium carbonate equivalent—2 to 10 percent
Rock fragments—15 to 35 percent
Reaction—moderately alkaline or strongly alkaline

2C horizons:
Hue—5YR, 7.5YR, or 10YR
Value—4 to 6 dry; 3 to 5 moist
Chroma—2 to 6, dry or moist
Texture—loamy sand, sandy loam, or fine sandy loam
Clay content—4 to 10 percent
Calcium carbonate equivalent—10 to 25 percent
Rock fragments—5 to 35 percent
Reaction—moderately alkaline or strongly alkaline

113—Moenkopie-Rock outcrop complex, 1 to 14 percent slopes

Map Unit Setting

Landform(s): Structural benches (figs. 111 and 112)
Elevation: 4,280 to 4,950 feet (1,305 to 1,509 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Moenkopie and similar soils: 70 percent
Rock outcrop, sandstone: 20 percent
Minor components: Torripsamments—10 percent

Description of the Moenkopie Soil

Taxonomic classification: Loamy, mixed, superactive, calcareous, mesic Lithic Torriorthents
Taxon kind: Series
Geomorphic position: Talf and dips on top of structural benches
Parent material: Residuum weathered from mudstone and/or residuum weathered from sandstone

Figure 111.—The Moenkopie soil in an area of Moenkopie-Rock outcrop complex, 1 to 14 percent slopes.

Figure 112.—Rock outcrop in an area of Moenkopie-Rock outcrop complex, 1 to 14 percent slopes.

Figure 113.—Surface of Moenkopie loamy coarse sand, in a very channery area.

Elevation: 4,280 to 4,950 feet (1,305 to 1,509 meters)
Slope: 1 to 14 percent
Depth to restrictive feature(s): 3 to 16 inches to paralithic bedrock; 4 to 20 inches to lithic bedrock
Drainage class: Excessively drained
K_{sat} *in solum:* 1.98 to 19.98 inches per hour (14.00 to 141.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.20 inch per hour (0.00 to 1.41 micrometers per second)
Available water capacity (total inches): 0.6 (very low)
Shrink-swell potential: About 0.6 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very high
Hydrologic group: D
Ecological site name: Sandstone/Shale Upland 6-10” p.z.
Ecological site number: R035XB215AZ
Present vegetation: Torrey’s jointfir, James’ galleta, fluffgrass, globemallow, broom snakeweed, and fourwing saltbush
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 113)

Canopy plant cover	4
Woody debris	0
Herbaceous litter	2
Bare soil	78
Channers	5

Figure 114.—Profile of Moenkopie soil. Scale is in centimeters.

Typical Pedon (figs. 114 through 117)

Location by Universal Transverse Mercator System: Zone 12N, 3933828 Northing, 472513 Easting

C1—0 to 2 inches (0 to 5 centimeters); reddish brown (2.5YR 4/3) loamy coarse sand, dusky red (2.5YR 3/2) moist; 7 percent clay; single grain; loose, nonsticky, nonplastic; few very fine roots throughout; common very fine interstitial pores; 5 percent gravel and 5 percent channers; slightly effervescent, 1 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; abrupt smooth boundary.

C2—2 to 13 inches (5 to 33 centimeters); reddish brown (2.5YR 4/3) channery loamy coarse sand, dusky red (2.5YR 3/2) moist; 4 percent clay; massive; slightly hard, friable, nonsticky, nonplastic; common very fine roots; common very fine irregular pores; 15 percent channers; very slightly effervescent, 2 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; clear smooth boundary.

Cr—13 to 15 inches (33 to 42 centimeters); fractured, weathered volcanic bedrock; abrupt smooth boundary.

R—15 inches (42 centimeters); fractured, unweathered sandstone.

Range in Characteristics

Rock fragment content of the control section: 0 to 30 percent
Clay content of particle-size control section: 3 to 10 percent

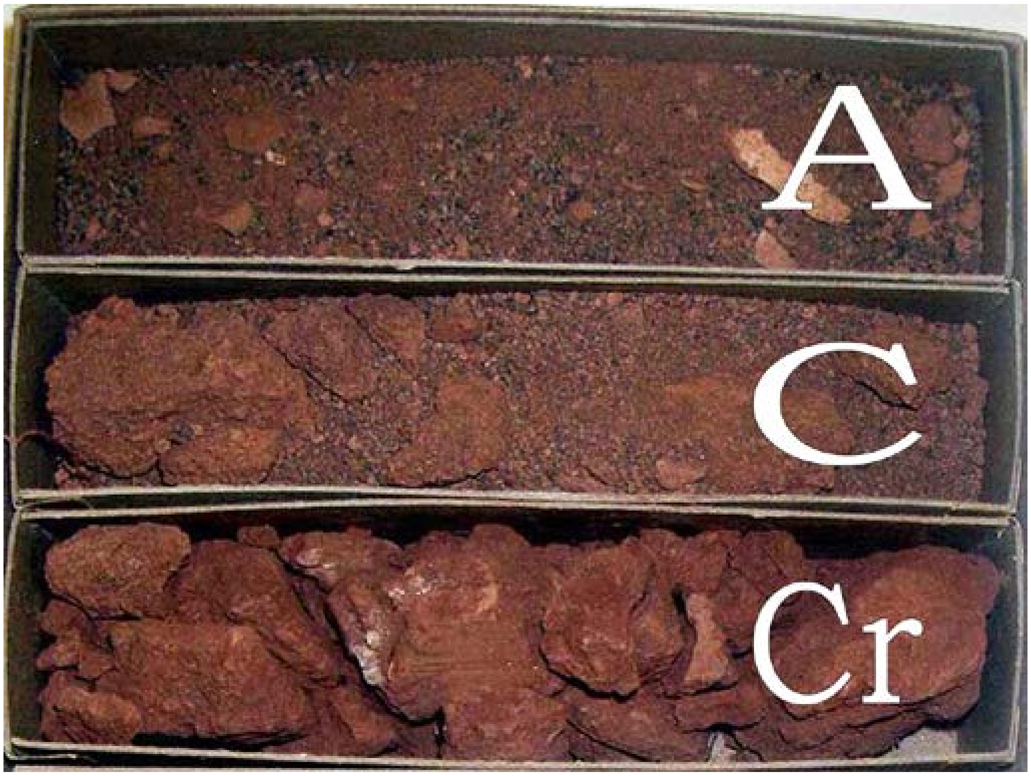


Figure 115.—Box sample of Moenkopie typical pedon.

Figure 116.—Surface sand fraction from Moenkopie typical pedon.

Figure 117.—Subsurface sand fraction from Moenkopie typical pedon.

C1 horizon:

Hue—2.5YR or 7.5YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—2 to 4, dry or moist
Texture—loamy coarse sand
Clay content—3 to 10 percent
Calcium carbonate equivalent—1 to 5 percent
Rock fragments—0 to 20 percent
Reaction—slightly alkaline or moderately alkaline

C2 horizon:

Hue—2.5YR or 7.5YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—2 to 4, dry or moist
Texture—loamy coarse sand, loam, or fine sandy loam
Clay content—3 to 10 percent
Calcium carbonate equivalent—0 to 2 percent
Gypsum content—0 to 2 percent
Rock fragments—0 to 35 percent
Reaction—slightly alkaline or moderately alkaline

Description of Rock Outcrop, Sandstone

The Rock outcrop consists of exposures of flat or rolling bedrock. Areas are typically barren but may have sparse vegetation growing in cracks and crevices or in thin layers of eolian, alluvial, or colluvial material.

Figure 118.—An area of Nalakihu loamy sand, 0 to 4 percent slopes.

114—Nalakihu loamy sand, 0 to 4 percent slopes

Map Unit Setting

Landform(s): Lava fields (fig. 118)
Elevation: 4,660 to 4,810 feet (1,421 to 1,467 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Nalakihu and similar soils: 85 percent
Minor components: Torriorthents—10 percent; Miburn soils—5 percent

Description of the Nalakihu Soil

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Vitrandic Haplocalcids
Taxon kind: Series
Geomorphic position: Talf on top of weathered beds of lava flows
Parent material: Residuum weathered from basalt
Elevation: 4,660 to 4,810 feet (1,421 to 1,467 meters)
Slope: 0 to 4 percent
Depth to restrictive feature(s): 20 to 40 inches to lithic bedrock
Drainage class: Somewhat excessively drained

Figure 119.—Surface of Nalakihu loamy sand.

K_{sat} in solum: 0.57 inch to 99.92 inches per hour (4.00 to 705.00 micrometers per second)
K_{sat} in restrictive layer: 0.00 to 0.06 inch per hour (0.00 to 0.42 micrometer per second)
Available water capacity (total inches): 3.1 (low)
Shrink-swell potential: About 2.3 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: High
Hydrologic group: C
Ecological site name: Loamy Upland 6-10" p.z.
Ecological site number: R035XB210AZ
Present vegetation: James' galleta, alkali sacaton, rubber rabbitbrush, Torrey's jointfir, dropseed, and fourwing saltbush
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 119)

Canopy plant cover	40
Woody debris	0
Herbaceous litter	0
Bare soil	10
Rock fragments (tephra)	10

Typical Pedon (figs. 120 through 123)

Location by Universal Transverse Mercator System: Zone 12N, 3931570 Northing, 471039 Easting

C—0 to 3 inches (0 to 7 centimeters); dark brown (7.5YR 3/3) loamy sand, very dark brown (7.5YR 2.5/2) moist; 5 percent clay; single grain; loose, nonsticky,

Figure 120.—Profile of Nalakihu soil. Scale is in centimeters.

nonplastic; interstitial pores; 5 percent cobbles and 5 percent cinders; slightly effervescent, 2 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; abrupt smooth boundary.

2A—3 to 7 inches (7 to 17 centimeters); pink (5YR 7/3) gravelly sandy loam, reddish brown (5YR 5/4) moist; 18 percent clay; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky, nonplastic; interstitial pores; 5 percent cobbles and 10 percent gravel; strongly effervescent, 5 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; gradual smooth boundary.

2Bk1—7 to 17 inches (17 to 42 centimeters); light reddish brown (5YR 6/3) sandy clay loam, reddish brown (5YR 5/4) moist; 22 percent clay; moderate subangular

Figure 121.—Box sample of Nalakihu typical pedon.

blocky structure; hard, friable, slightly sticky, slightly plastic; many very fine and common fine roots throughout; many very fine dendritic tubular pores; many irregular carbonate masses around rock fragments and finely disseminated carbonate in matrix; 5 percent gravel and 7 percent cobbles; violently effervescent, 15 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; gradual smooth boundary.

2Bk2—17 to 27 inches (42 to 67 centimeters); pinkish gray (5YR 7/2) gravelly loam, reddish brown (5YR 5/3) moist; 20 percent clay; moderate fine subangular blocky structure; hard, friable, slightly sticky, slightly plastic; common very fine roots throughout; common very fine dendritic tubular pores; common irregular carbonate masses around rock fragments and finely disseminated carbonate in matrix; 5 percent cobbles and 15 percent gravel; violently effervescent, 15 percent calcium carbonate equivalent; strongly alkaline, pH 8.6; abrupt smooth boundary.

2R—27 inches (67 centimeters); fractured, unweathered basalt.

Range in Characteristics

Rock fragment content of the control section: 0 to 25 percent
Clay content of particle-size control section: 18 to 27 percent
Volcanic glass content: 5 to 10 percent
Calcic horizon: The zone from 7 to 26 inches (17 to 67 centimeters) (Bk horizons)

C horizon:
Hue—7.5YR or 10YR

Figure 122.—Surface sand fraction from Nalakihu typical pedon.

Figure 123.—Subsurface sand fraction from Nalakihu typical pedon.

Value—3 to 4 dry; 2.5 to 3 moist
Chroma—2 to 4, dry or moist
Texture—loamy sand
Clay content—3 to 7 percent
Calcium carbonate equivalent—2 to 5 percent
Rock fragments—0 to 20 percent cinders
Reaction—moderately alkaline or strongly alkaline

2A horizon:
Hue—5YR, 7.5YR, or 10YR
Value—3 to 7 dry; 2.5 to 5 moist
Chroma—2 to 4, dry or moist
Texture—sandy loam or sandy clay loam
Clay content—15 to 27 percent
Calcium carbonate equivalent—2 to 10 percent
Rock fragments—0 to 30 percent cinders
Reaction—moderately alkaline or strongly alkaline

2Bk horizons:
Hue—5YR, 7.5YR, or 10YR
Value—5 to 7 dry; 4 to 6 moist
Chroma—2 to 4, dry or moist
Texture—sandy clay loam, loam, or sandy loam
Clay content—18 to 27 percent
Carbonate equivalent—15 to 30 percent
Rock fragments—0 to 25 percent
Reaction—moderately alkaline or strongly alkaline

115—Peshlaki-Rock outcrop complex, 1 to 11 percent slopes

Map Unit Setting

Landform(s): Structural benches (figs. 124 and 125)
Elevation: 4,500 to 5,530 feet (1,373 to 1,685 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Peshlaki and similar soils: 75 percent
Rock outcrop, limestone: 10 percent
Minor components: Haplocambids—15 percent

Description of the Peshlaki Soil

Taxonomic classification: Ashy-skeletal, glassy, nonacid, mesic Lithic Ustic Torriorthents
Taxon kind: Series
Geomorphic position: Talfs and dips across eroded flat structural benches
Parent material: Cinders derived from volcanic rock over residuum weathered from limestone
Elevation: 4,500 to 5,530 feet (1,373 to 1,685 meters)

Figure 124.—The Peshlaki soil in an area of Peshlaki-Rock outcrop complex, 1 to 11 percent slopes.

Figure 125.—Rock outcrop in an area of Peshlaki-Rock outcrop complex, 1 to 11 percent slopes.

Figure 126.—Surface of Peshlaki extremely gravelly coarse sand.

Figure 127.—Profile of Peshlaki soil. Scale is in centimeters.

Figure 128.—Box sample of Peshlaki typical pedon.

Slope: 1 to 11 percent
Depth to restrictive feature(s): 7 to 17 inches to lithic bedrock
Drainage class: Excessively drained
K_{sat} *in solum:* 5.95 to 99.92 inches per hour (42.00 to 705.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.06 inch per hour (0.00 to 0.42 micrometer per second)
Available water capacity (total inches): 0.3 (very low)
Shrink-swell potential: About 0.3 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Negligible
Hydrologic group: D
Ecological site name: Volcanic Upland 10-14” p.z.
Ecological site number: R035XA108AZ
Present vegetation: Black grama, oneseed juniper, James’ galleta, lambert crazyweed, and Indian ricegrass
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 126)

Canopy plant cover	22
Woody debris	0
Herbaceous litter	8
Bare soil	0
Rock fragments (tephra)	35

Typical Pedon (figs. 127 through 130)

Location by Universal Transverse Mercator System: Zone 12N, 3933788 Northing, 459137 Easting

C—0 to 1 inch (0 to 3 centimeters); very dark gray (7.5YR 3/1) extremely gravelly coarse sand, black (7.5YR 2.5/1) moist; 2 percent clay; single grain; loose, nonsticky, nonplastic; common very fine roots throughout; many interstitial pores; 65 percent cinders; noneffervescent; moderately alkaline, pH 8.0; abrupt smooth boundary.

Bk—1 to 7 inches (3 to 18 centimeters); brown (7.5YR 4/2) very gravelly loamy sand, black (7.5YR 2.5/1) moist; 6 percent clay; massive and moderate fine granular

Figure 129.—Surface sand fraction from Peshlaki typical pedon.

Figure 130.—Subsurface sand fraction from Peshlaki typical pedon.

structure; soft, very friable, nonsticky, nonplastic; many very fine roots throughout; many interstitial pores; common fine carbonate masses around rock fragments; 45 percent cinders; very slightly effervescent, 1 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; abrupt wavy boundary.

2R—7 inches (18 centimeters); fractured, unweathered limestone.

Range in Characteristics

Rock fragment content of the control section: 35 to 65 percent cinders
Clay content of particle-size control section: 3 to 9 percent
Volcanic glass content: 30 to 40 percent

C horizon:
Hue—7.5YR or 10YR
Value—2.5 or 3 dry; 2.5 moist
Chroma—1 or 2, dry or moist
Texture—coarse sand
Clay content—1 to 6 percent
Rock fragments—35 to 80 percent cinders
Reaction—moderately alkaline

Bk horizon:
Hue—7.5YR or 10YR
Value—2.5 to 5 dry; 2.5 to 4 moist
Chroma—1 to 4, dry or moist
Texture—loamy sand or sandy loam
Clay content—3 to 10 percent
Carbonate equivalent—0 to 2 percent
Rock fragments—25 to 60 percent cinders
Reaction—moderately alkaline

Description of Rock Outcrop, Limestone

The Rock outcrop consists of exposures of flat or rolling bedrock. Areas are typically barren but may have sparse vegetation growing in cracks and crevices or in thin layers of eolian, alluvial, or colluvial material.

116—Rock outcrop-Typic Torriorthents-Heiser association, 3 to 40 percent slopes

Map Unit Setting

Landform(s): Escarpments (figs. 131, 132, and 133)
Elevation: 4,340 to 4,960 feet (1,323 to 1,512 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Rock outcrop, sandstone: 35 percent
Typic Torriorthents and similar soils: 30 percent
Heiser and similar soils: 25 percent
Minor components: Miburn soils—10 percent

Figure 131.—Rock outcrop in an area of Rock outcrop-Typic Torriorthents-Heiser association, 3 to 40 percent slopes.

Description of Rock Outcrop, Sandstone

The Rock outcrop consists of exposures of steep bedrock and escarpments. Areas are typically barren but may have sparse vegetation growing in cracks and crevices or in thin layers of eolian, alluvial, or colluvial material.

Description of Typic Torriorthents

Taxonomic classification: Typic Torriorthents
Taxon kind: Taxon above family
Geomorphic position: Footslopes and side slopes beneath canyon escarpments
Parent material: Residuum weathered from sandstone and shale
Elevation: 4,340 to 4,960 feet (1,323 to 1,512 meters)
Slope: 3 to 40 percent
Depth to restrictive feature(s): 5 to 20 inches to paralithic bedrock
Drainage class: Well drained
K_{sat} *in solum:* 0.20 inch to 1.98 inches per hour (1.40 to 14.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.10 inch per hour (0.00 to 0.70 micrometer per second)
Available water capacity (total inches): 1.3 (very low)
Shrink-swell potential: About 1.8 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very high
Hydrologic group: D
Ecological site name: Sandstone/Shale Upland 6-10” p.z.
Ecological site number: R035XB215AZ

Figure 132.—Typic Torriorthents in an area of Rock outcrop-Typic Torriothents-Heiser association, 3 to 40 percent slopes.

Figure 133.—The Heiser soil in an area of Rock outcrop-Typic Torriorthents-Heiser association, 3 to 40 percent slopes.

Figure 134.—Surface of Typic Torriorthents, channery sandy clay loam, in an extremely channery area.

Present vegetation: Apache plume, fourwing saltbush, bush muhly, Cutler's jointfir, broom snakeweed, Phacelia, sand sagebrush, and sumac
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 134)

Canopy plant cover	6
Woody debris	0
Herbaceous litter	4
Bare soil	30
Gravel	20
Channers	35
Cobbles	15

Typical Pedon (figs. 135 through 138)

Location by Universal Transverse Mercator System: Zone 12N, 3932059 Northing, 468504 Easting

A—0 to 4 inches (0 to 10 centimeters); yellowish red (5YR 4/6) channery sandy clay loam, dark reddish brown (5YR 3/4) moist; 22 percent clay; moderate medium granular structure; soft, very friable, moderately sticky, moderately plastic; few very fine roots throughout; common very fine irregular pores; 10 percent gravel and 20 percent channers; strongly effervescent, 10 percent calcium carbonate equivalent and 1 percent gypsum; moderately alkaline, pH 8.0; abrupt smooth boundary.

C—4 to 12 inches (10 to 31 centimeters); reddish brown (5YR 4/4) extremely channery clay loam, dark reddish brown (5YR 3/4) moist; 28 percent clay; massive; slightly hard, friable, very sticky, very plastic; common very fine and many fine roots

Figure 135.—Profile of Typic Torriorthents. Scale is in centimeters.

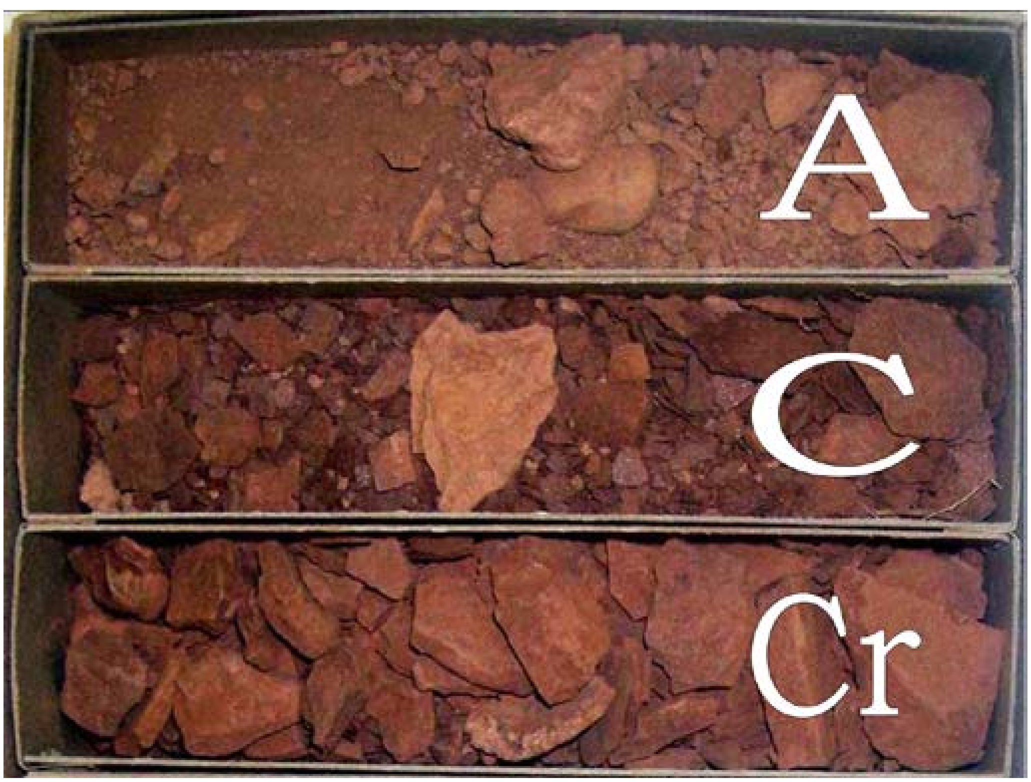


Figure 136.—Box sample of Typic Torriorthents typical pedon.

Figure 137.—Surface sand fraction from Typic Torriorthents typical pedon.

Figure 138.—Subsurface sand fraction from Typic Torriorthents typical pedon.

throughout; 60 percent channers; strongly effervescent, 10 percent calcium carbonate equivalent and 1 percent gypsum; moderately alkaline, pH 8.0; abrupt smooth boundary.

Cr—12 inches (31 centimeters); fractured, weathered shale.

Range in Characteristics

Note: Typic Torriorthents have soil properties that vary beyond family class limits.

Rock fragment content of the control section: 35 to 80 percent
Clay content of particle-size control section: 27 to 35 percent

A horizon:
Hue—5YR or 10YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—4 to 6, dry or moist
Texture—sandy clay loam
Clay content—22 to 30 percent
Calcium carbonate equivalent—10 to 15 percent
Gypsum content—0 to 2 percent
Rock fragments—5 to 45 percent
Reaction—moderately alkaline

C horizon:
Hue—5YR or 10YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—4 to 6, dry or moist
Texture—sandy clay loam or clay loam
Clay content—27 to 35 percent
Calcium carbonate equivalent—10 to 15 percent
Gypsum content—0 to 2 percent
Rock fragments—35 to 80 percent
Reaction—moderately alkaline

Description of the Heiser Soil

Taxonomic classification: Ashy, glassy, nonacid, mesic Vitrandic Torripsamments
Taxon kind: Series
Geomorphic position: Shoulders and side slopes beneath canyon escarpments
Parent material: Tephra derived from volcanic rock
Elevation: 4,340 to 4,960 feet (1,323 to 1,512 meters)
Slope: 3 to 40 percent
Drainage class: Excessively drained
K_{sat} *in solum:* 5.95 to 19.98 inches per hour (42.00 to 141.00 micrometers per second)
Available water capacity (total inches): 2.2 (very low)
Shrink-swell potential: About 0.2 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Low
Hydrologic group: A
Ecological site name: Sandstone/Shale Upland 6-10” p.z.
Ecological site number: R035XB215AZ
Present vegetation: Apache plume, fourwing saltbush, bush muhly, Cutler’s jointfir, broom snakeweed, Phacelia, sand sagebrush, and sumac
Land capability (nonirrigated areas): 7c

Figure 139.—Surface of Heiser coarse sand, in a gravelly area.

Surface cover (percent): (fig. 139)

Canopy plant cover	22
Woody debris	4
Herbaceous litter	26
Bare soil	4
Rock fragments (cinders)	10

Typical Pedon (figs. 140 through 143)

Location by Universal Transverse Mercator System: Zone 12N, 3932128 Northing, 468412 Easting

C1—0 to 10 inches (0 to 26 centimeters); very dark gray (10YR 3/1) coarse sand, black (10YR 2/1) moist; 6 percent clay; weak fine granular structure; loose, nonsticky, nonplastic; few very fine roots throughout; 10 percent cinders; noneffervescent; slightly alkaline, pH 7.8; clear wavy boundary.

C2—10 to 38 inches (26 to 97 centimeters); very dark gray (7.5YR 3/1) gravelly coarse sand, black (7.5YR 2.5/1) moist; 4 percent clay; weak fine granular structure; loose, nonsticky, nonplastic; common very fine and fine roots throughout; 15 percent cinders; noneffervescent; slightly alkaline, pH 7.8; gradual smooth boundary.

C3—38 to 60 inches (97 to 152 centimeters); very dark gray (7.5YR 3/1) gravelly coarse sand, black (7.5YR 2.5/1) moist; 2 percent clay; single grain; loose, nonsticky, nonplastic; 25 percent cinders; noneffervescent; slightly alkaline, pH 7.6; gradual smooth boundary.

Figure 140.—Profile of Heiser soil. Scale is in centimeters.

Range in Characteristics

Rock fragment content of the control section: 0 to 30 percent cinders
Clay content of particle-size control section: 1 to 5 percent
Volcanic glass content: 30 to 40 percent

C horizons:
Hue—7.5YR or 10YR
Value—2.5 to 4 dry; 2 to 3 moist
Chroma—1 or 2, dry or moist
Texture—coarse sand, sand, or loamy sand
Clay content—1 to 7 percent
Rock fragments—0 to 45 percent cinders
Reaction—slightly alkaline or moderately alkaline

Figure 141.—Box sample of Heiser typical pedon.

Figure 142.—Surface sand fraction from Heiser typical pedon.

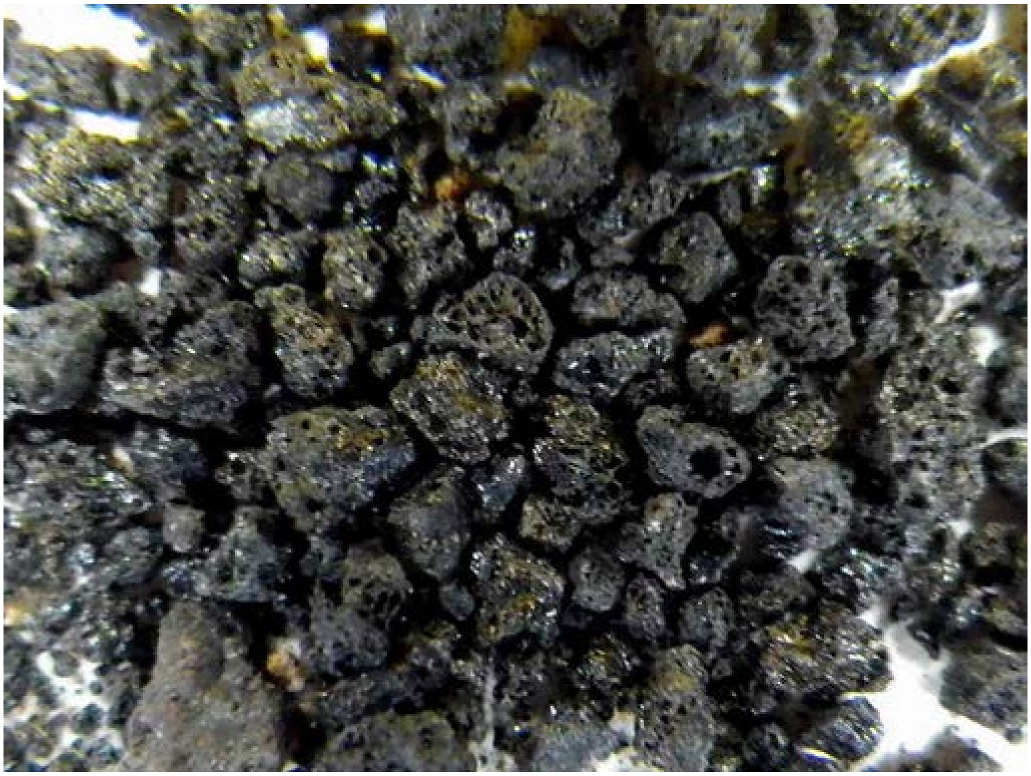


Figure 143.—Subsurface sand fraction from Heiser family typical pedon.

117—Sandy, Typic Torriorthents, 1 to 15 percent slopes

Map Unit Setting

Landform(s): Cuestas and dip slopes (fig. 144)
Elevation: 4,420 to 4,550 feet (1,348 to 1,386 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Sandy, Typic Torriorthents and similar soils: 100 percent

Description of the Sandy, Typic Torriorthents

Taxonomic classification: Sandy, mixed, mesic Typic Torriorthents
Taxon kind: Taxon above family
Geomorphic position: Summits on top of dip slopes of cuestas
Parent material: Residuum weathered from conglomerate, residuum weathered from arkose, and/or residuum weathered from sandstone
Elevation: 4,420 to 4,550 feet (1,348 to 1,386 meters)
Depth to restrictive feature(s): 40 to 60 inches to paralithic bedrock
Drainage class: Somewhat excessively drained
K_{sat} *in solum:* 0.57 inch to 19.98 inches per hour (4.00 to 141.00 micrometers per second)

Figure 144.—An area of Sandy, Typic Torriorthents, 1 to 15 percent slopes.

K_{sat} in restrictive layer: 0.00 to 0.20 inch per hour (0.00 to 1.41 micrometers per second)
Available water capacity (total inches): 2.7 (low)
Shrink-swell potential: About 1.4 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very low
Hydrologic group: B
Ecological site name: Sandstone/Shale Upland 6-10” p.z.
Ecological site number: R035XB215AZ
Present vegetation: Torrey’s jointfir, mesa dropseed, Indian ricegrass, James’ galleta, buckwheat, narrowleaf stoneseed, narrowleaf yucca, rosemary mint, sand sagebrush, woody crinklemat, globemallow, primrose, forbs, and annuals
Land capability (nonirrigated areas): 7c
Slope: 1 to 15 percent
Surface cover (percent): (fig. 145)

Canopy plant cover	12
Woody debris	0
Herbaceous litter	4
Bare soil	58
Gravel	70

Typical Pedon (figs. 146 through 149)

Location by Universal Transverse Mercator System: Zone 12N, 3935011 Northing, 473310 Easting

Figure 145.—Surface of Sandy, Typic Torriorthents, gravelly sandy loam, in an extremely gravelly area.

A—0 to 3 inches (0 to 8 centimeters); reddish brown (5YR 5/4) gravelly sandy loam, reddish brown (5YR 4/4) moist; 19 percent clay; weak thin platy and moderate fine angular blocky structure; soft, very friable, slightly sticky, slightly plastic; many medium and few very fine roots throughout; interstitial pores; 20 percent gravel; strongly effervescent, 10 percent calcium carbonate equivalent; moderately alkaline, pH 8.4; clear wavy boundary.

C1—3 to 19 inches (8 to 48 centimeters); brown (7.5YR 5/4) sand, brown (7.5YR 4/4) moist; 2 percent clay; weak fine angular blocky structure; soft, very friable, nonsticky, nonplastic; common very fine and fine roots throughout; interstitial and few very fine irregular pores; 2 percent gravel; strongly effervescent, 10 percent calcium carbonate equivalent; slightly alkaline, pH 7.8; clear wavy boundary.

C2—19 to 25 inches (48 to 63 centimeters); light brown (7.5YR 6/4) extremely gravelly sand, brown (7.5YR 5/4) moist; 4 percent clay; massive; soft, very friable, nonsticky, nonplastic; common very fine roots throughout; interstitial and few very fine and few fine irregular pores; 65 percent gravel; very slightly effervescent, 1 percent calcium carbonate equivalent; moderately alkaline, pH 8.0; clear wavy boundary.

C3—25 to 47 inches (63 to 120 centimeters); brown (7.5YR 5/4) fine sand, brown (7.5YR 5/4) moist; 4 percent clay; soft, very friable, nonsticky, nonplastic; common very fine roots throughout; interstitial and few very fine irregular and few fine irregular pores; 5 percent gravel; strongly effervescent, 10 percent calcium carbonate equivalent; moderately alkaline, pH 8.0; clear wavy boundary.

Cr—47 inches (120 centimeters); fractured, weathered sandstone.

Figure 146.—Profile of Sandy, Typic Torriorthents. Scale is in centimeters.

Range in Characteristics

Note: Sandy, Typic Torriorthents have soil properties that vary beyond family class limits.

Rock fragment content of the control section: 0 to 35 percent
Clay content of particle-size control section: 2 to 8 percent

A horizon:
Hue—5YR or 7.5YR
Value—5 or 6 dry; 4 or 5 moist

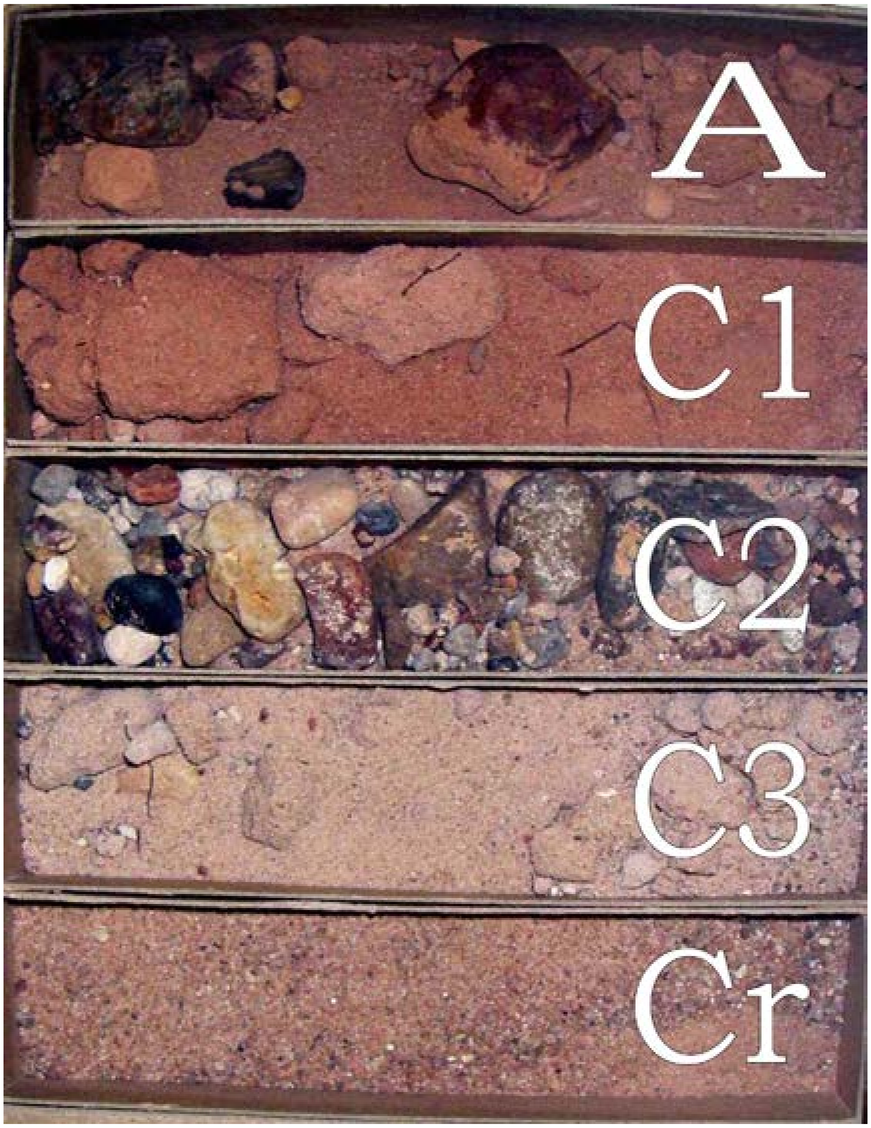


Figure 147.—Box sample of Sandy, Typic Torriorthents typical pedon.

Chroma—3 or 4, dry or moist
Texture—sandy loam
Clay content—10 to 20 percent
Calcium carbonate equivalent—2 to 10 percent
Rock fragments—15 to 35 percent
Reaction—slightly alkaline or moderately alkaline

C horizons:
Hue—5YR or 7.5YR
Value—4 to 7 dry; 4 or 5 moist
Chroma—3 or 4, dry or moist
Texture—sand, fine sand, or loamy sand
Clay content—2 to 8 percent
Calcium carbonate equivalent—0 to 10 percent
Rock fragments—0 to 70 percent
Reaction—slightly alkaline or moderately alkaline

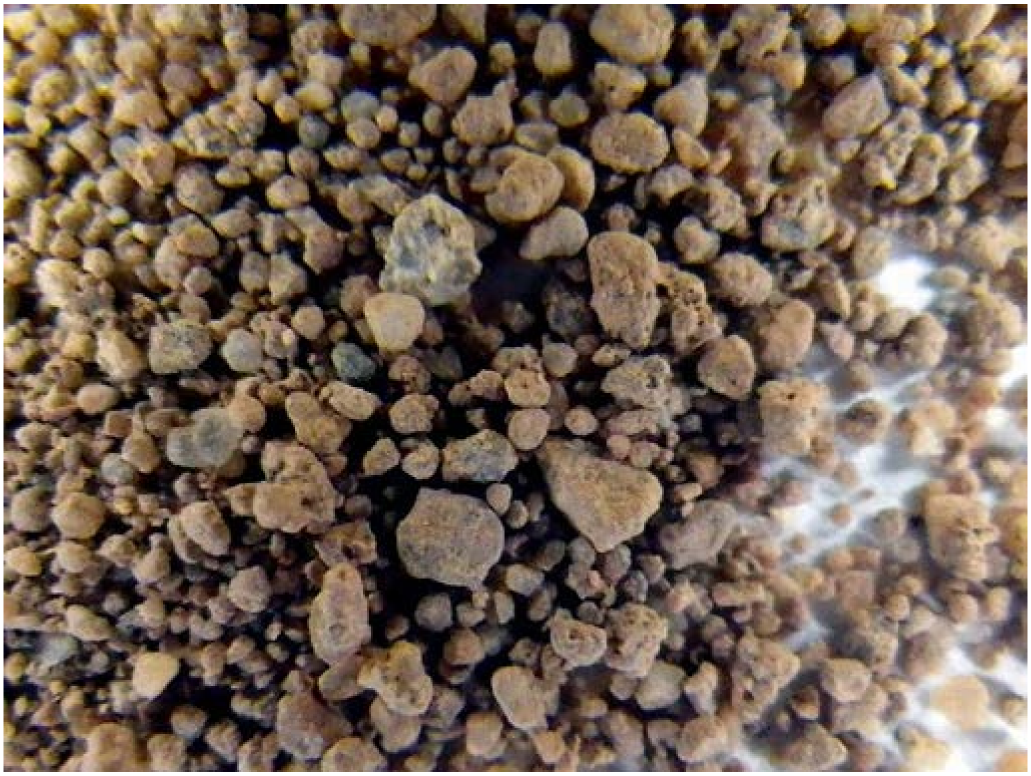


Figure 148.—Surface sand fraction from Sandy, Typic Torriorthents typical pedon.

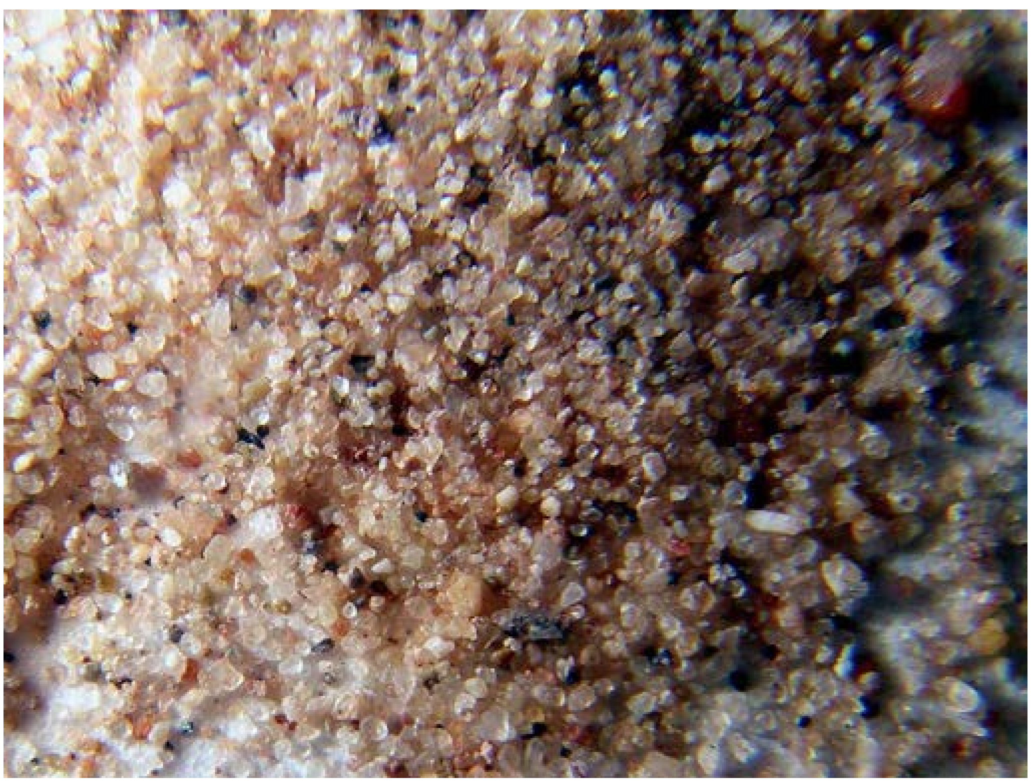


Figure 149.—Subsurface sand fraction from Sandy, Typic Torriorthents typical pedon.

Figure 150.—An area of Shinume channery sandy clay loam, 2 to 30 percent slopes.

118—Shinume channery sandy clay loam, 2 to 30 percent slopes

Map Unit Setting

Landform(s): Cuestas and escarpments (fig. 150)
Elevation: 4,280 to 4,900 feet (1,305 to 1,495 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Shinume and similar soils: 85 percent
Minor components: Torripsamments—10 percent; Badland—5 percent

Description of the Shinume Soil

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Torriorthents
Taxon kind: Series
Geomorphic position: Side slopes on escarpments of cuestas
Parent material: Residuum weathered from sandstone and shale
Elevation: 4,280 to 4,900 feet (1,305 to 1,495 meters)
Slope: 2 to 30 percent

Figure 151.—Surface of Shinume channery sandy clay loam, in an extremely channery area.

Depth to restrictive feature(s): 4 to 20 inches to lithic bedrock
Drainage class: Well drained
K_{sat} *in solum:* 0.57 inch to 1.98 inches per hour (4.00 to 14.00 micrometers per second)
K_{sat} *in restrictive layer:* 0.00 to 0.20 inch per hour (0.00 to 1.41 micrometers per second)
Available water capacity (total inches): 1.3 (very low)
Shrink-swell potential: About 2.2 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Very high
Hydrologic group: D
Ecological site name: Sandstone/Shale Upland 6-10” p.z.
Ecological site number: R035XB215AZ
Present vegetation: Torrey’s jointfir, James’ galleta, fourwing saltbush, fluffgrass, and Indian ricegrass
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 151)

Canopy plant cover	24
Woody debris	0
Herbaceous litter	4
Bare soil	60
Gravel	20

Typical Pedon (figs. 152 through 155)

Location by Universal Transverse Mercator System: Zone 12N, 3935197 Northing, 473005 Easting

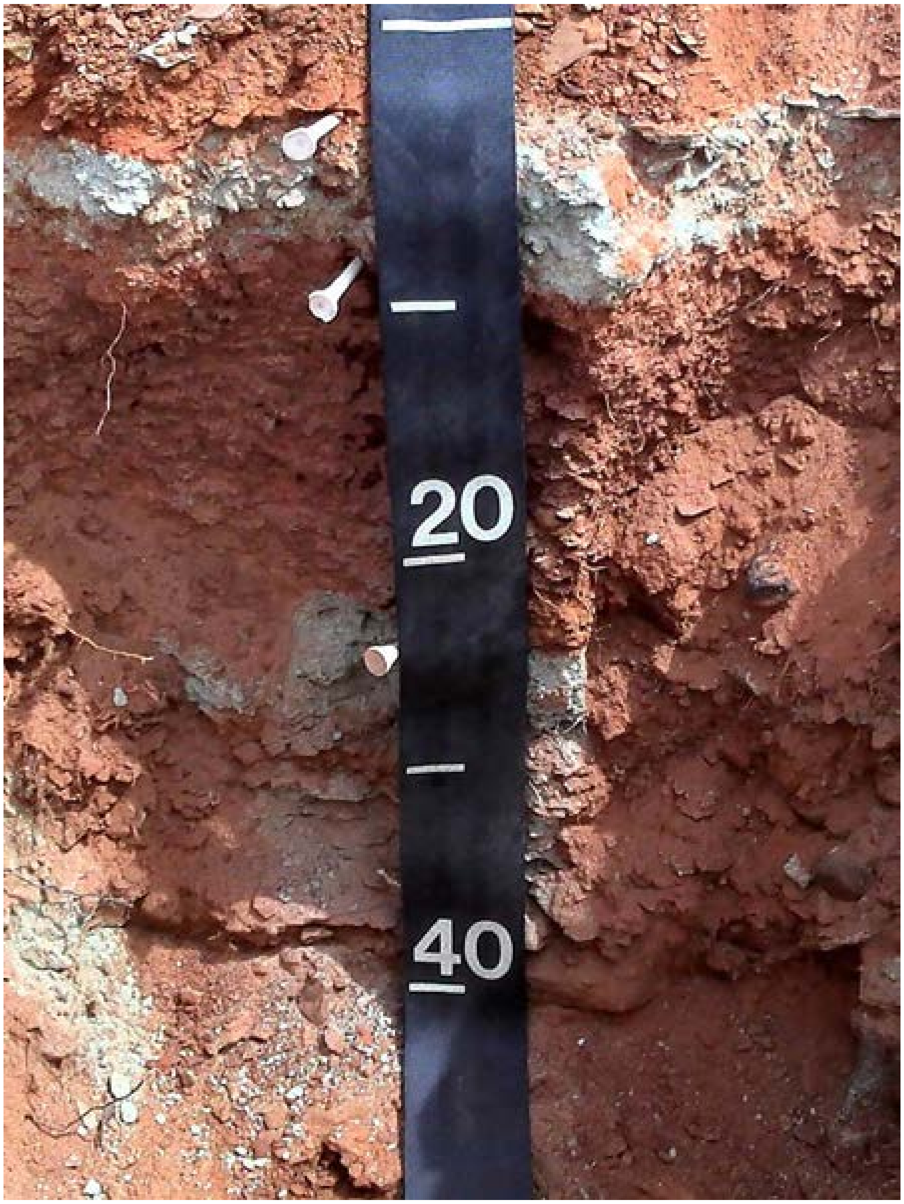


Figure 152.—Profile of Shinume soil. Scale is in centimeters.

C—0 to 3 inches (0 to 6 centimeters); reddish brown (5YR 4/4) channery sandy clay loam, dark reddish brown (5YR 3/4) moist; 25 percent clay; single grain; loose, slightly sticky, slightly plastic; common very fine roots throughout; common irregular pores; 10 percent gravel and 20 percent channers; violently effervescent, 15 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; abrupt wavy boundary.

Cy1—3 to 5 inches (6 to 12 centimeters); light brownish gray (10YR 6/2) channery sandy loam, brown (10YR 5/3) moist; 16 percent clay; weak fine platy structure; slightly hard, friable, slightly sticky, nonplastic; many very fine roots throughout; common very fine irregular pores; common gypsum crystals; 25 percent channers; violently effervescent, 15 percent calcium carbonate equivalent and 2 percent gypsum; moderately alkaline, pH 8.0; clear wavy boundary.

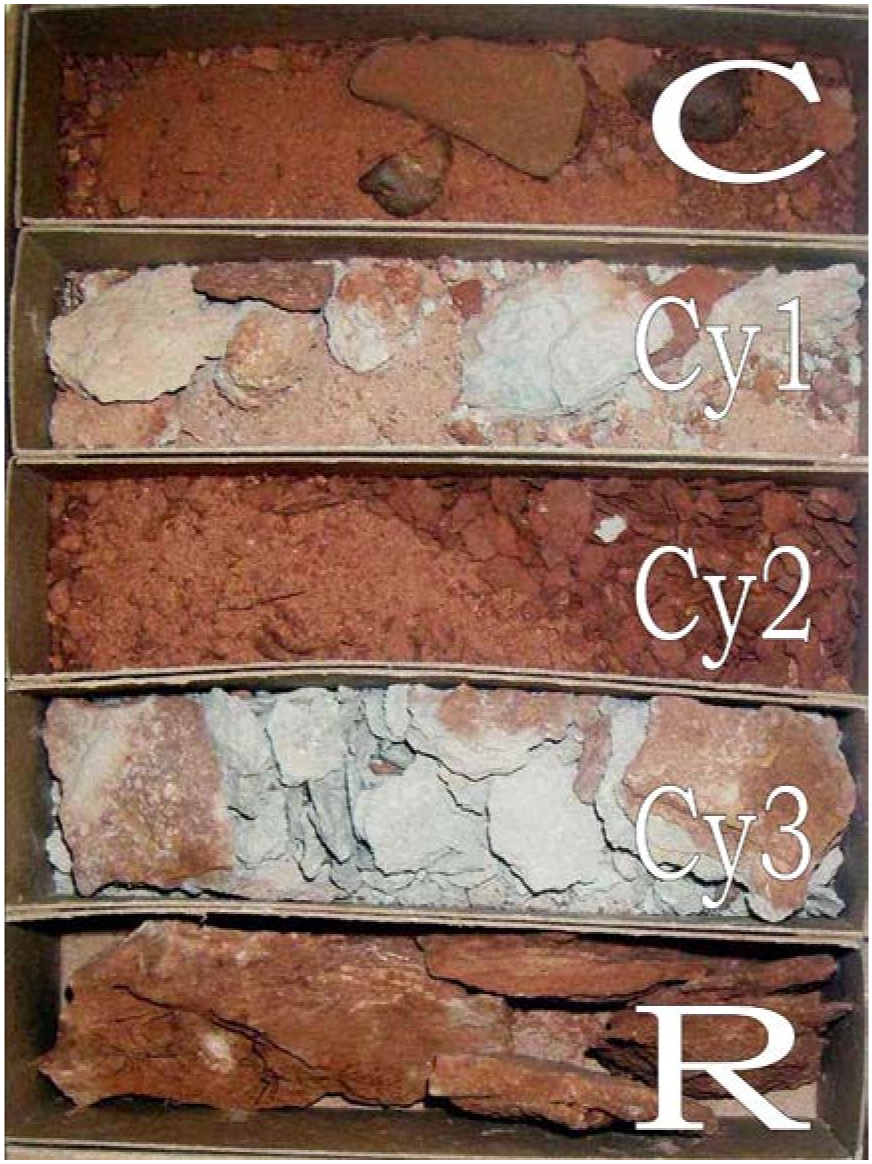


Figure 153.—Box sample of Shinume typical pedon.

Cy2—5 to 11 inches (12 to 27 centimeters); reddish brown (5YR 4/4) very channery sandy loam, dark reddish brown (5YR 3/4) moist; 18 percent clay; weak fine platy structure; slightly hard, friable, slightly sticky, nonplastic; few medium and many very fine roots throughout; common very fine dendritic tubular pores; common gypsum crystals; 50 percent channers; violently effervescent, 15 percent calcium carbonate equivalent and 2 percent gypsum; slightly alkaline, pH 7.8; clear wavy boundary.

Cy3—11 to 16 inches (27 to 40 centimeters); light brownish gray (10YR 6/2) very channery sandy loam, brown (10YR 5/3) moist; 16 percent clay; massive; slightly hard, friable, slightly sticky, nonplastic; few very fine and common fine roots throughout; common very fine irregular pores; common gypsum crystals; 55 percent channers; violently effervescent, 15 percent calcium carbonate equivalent and 2 percent gypsum; moderately alkaline, pH 8.0; clear wavy boundary.

R—16 inches (40 centimeters); fractured, unweathered shale.

Figure 154.—Surface sand fraction from Shinume typical pedon.

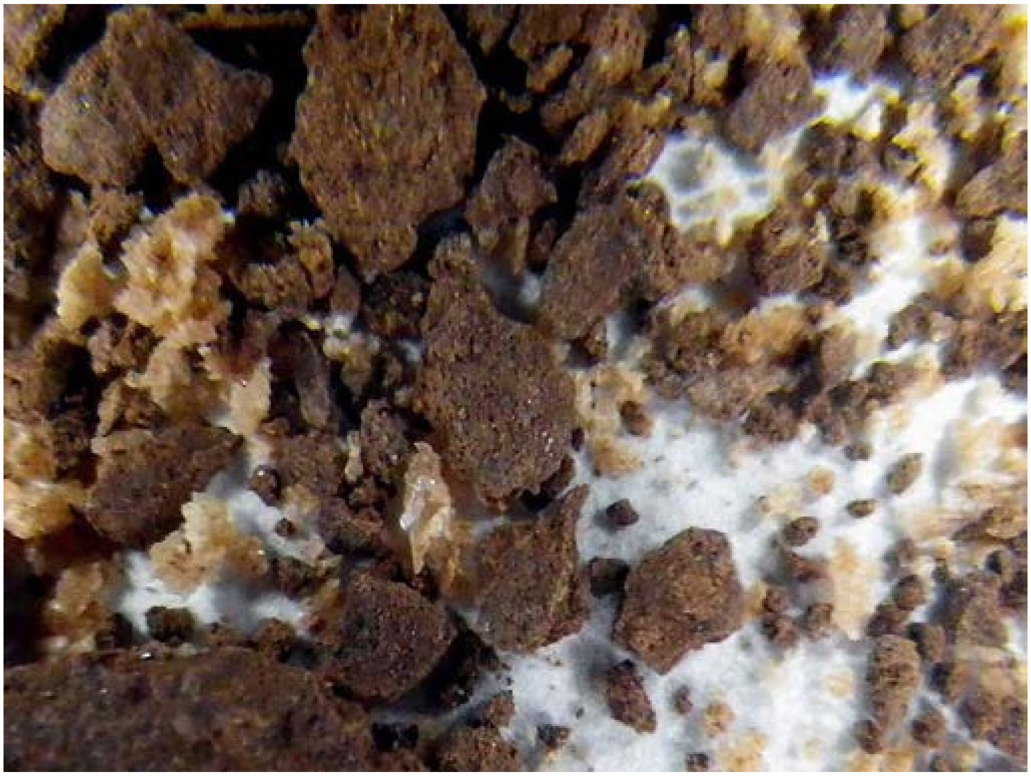


Figure 155.—Subsurface sand fraction from Shinume typical pedon.

Range in Characteristics

Rock fragment content of the control section: 35 to 60 percent
Clay content of particle-size control section: 12 to 18 percent

C horizon:
Hue—5YR or 10YR
Value—4 or 5 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—sandy clay loam
Clay content—20 to 30 percent
Calcium carbonate equivalent—10 to 25 percent
Rock fragments—15 to 35 percent
Reaction—slightly alkaline or moderately alkaline

Cy horizons:
Hue—5YR or 10YR
Value—4 to 6 dry; 3 to 5 moist
Chroma—2 to 6, dry or moist
Texture—sandy loam or loamy very fine sand
Clay content—12 to 18 percent
Calcium carbonate equivalent—10 to 25 percent
Gypsum content—0 to 5 percent
Rock fragments—15 to 60 percent
Reaction—slightly alkaline or moderately alkaline

119—Trachute-Lava flows complex, very rarely flooded, 0 to 5 percent slopes

Map Unit Setting

Landform(s): Lava flows and terraces (figs. 156 and 157)
Elevation: 4,280 to 4,340 feet (1,306 to 1,323 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12.0 to 14.0 degrees C)
Mean annual soil temperature: 56 to 59 degrees F (13.1 to 15.1 degrees C)
Frost-free period: 150 to 180 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.2—Colorado Plateau-Shrub - Grasslands

Map Unit Composition

Trachute and similar soils: 80 percent
Lava flows, basalt: 10 percent
Minor components: Loamy, Lithic Torriorthents—10 percent

Description of the Trachute, Tephra Soil

Taxonomic classification: Coarse-loamy, mixed, superactive, calcareous, mesic Typic Torriorthents
Taxon kind: Series
Geomorphic position: Treads of terraces
Parent material: Alluvium derived from volcanic and sedimentary rock
Elevation: 4,280 to 4,340 feet (1,306 to 1,323 meters)
Slope: 0 to 5 percent
Drainage class: Somewhat excessively drained
K_{sat} *in solum:* 1.98 to 5.95 inches per hour (14.00 to 42.00 micrometers per second)

Figure 156.—The Trachute soil in an area of Trachute-Lava flows complex, very rarely flooded, 0 to 5 percent slopes.

Figure 157.—Lava flows in an area of Trachute-Lava flows complex, very rarely flooded, 0 to 5 percent slopes.

Figure 158.—Surface of Trachute loamy coarse sand, in a gravelly area.

Available water capacity (total inches): 6.4 (moderate)
Shrink-swell potential: About 1.0 LEP (low)
Flooding hazard: Very rare
Ponding hazard: None
Runoff class: Very low
Hydrologic group: A
Ecological site name: Basalt Upland 6-10” p.z.
Ecological site number: R035XB231AZ
Present vegetation: Alkali sacaton, shadscale, galleta, fourwing saltbush, broom snakeweed, Torrey’s jointfir, forbs, and annuals
Land capability (nonirrigated areas): 7c
Surface cover (percent): (fig. 158)

Canopy plant cover	14
Woody debris	2
Herbaceous litter	12
Bare soil	76
Rock fragments (tephra)	15
Cobbles	5

Typical Pedon (figs. 159 through 162)

Location by Universal Transverse Mercator System: Zone 12N, 3936644 Northing, 474612 Easting

Ay—0 to 2 inches (0 to 4 centimeters); very dark gray (7.5YR 3/1) loamy coarse sand, black (7.5YR 2.5/1) moist; 10 percent clay; moderate thick platy structure; slightly hard, friable, nonsticky, nonplastic; common very fine roots throughout; many very fine vesicular pores; few fine gypsum masses in matrix; violently effervescent, 10

Figure 159.—Profile of Trachute soil. Scale is in centimeters.

percent calcium carbonate equivalent and 2 percent gypsum; strongly alkaline, pH 8.6; clear smooth boundary.

2By1—2 to 12 inches (4 to 29 centimeters); reddish brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) moist; 14 percent clay; weak medium subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; few medium and many very fine roots throughout; few medium dendritic tubular and common very fine vesicular pores; common fine gypsum masses in matrix; 5 percent gravel; violently effervescent, 15 percent calcium carbonate equivalent and 4 percent gypsum; moderately alkaline, pH 8.4; clear smooth boundary.

2By2—12 to 32 inches (29 to 80 centimeters); brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/3) moist; 11 percent clay; weak fine subangular blocky structure; soft, very friable, nonsticky, nonplastic; many very fine roots throughout; common

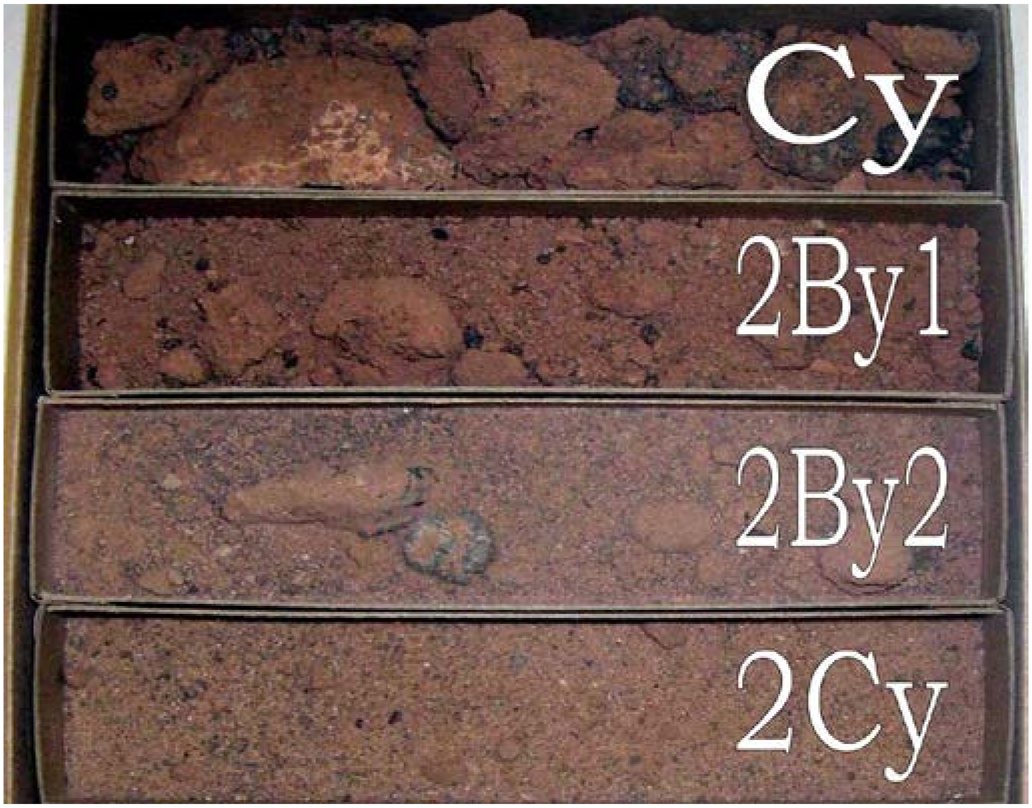


Figure 160.—Box sample of Trachute typical pedon.

Figure 161.—Surface sand fraction from Trachute typical pedon.

Figure 162.—Subsurface sand fraction from Trachute typical pedon.

very fine vesicular pores; few fine gypsum masses in matrix; violently effervescent, 15 percent calcium carbonate equivalent and 2 percent gypsum; strongly alkaline, pH 8.6; clear smooth boundary.

2Cy—32 to 60 inches (80 to 152 centimeters); brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/3) moist; 4 percent clay; massive; soft, very friable, nonsticky, nonplastic; few very fine roots throughout; common very fine vesicular pores; few fine gypsum masses in matrix; violently effervescent, 15 percent calcium carbonate equivalent and 1 percent gypsum; strongly alkaline, pH 8.6.

Range in Characteristics

Rock fragment content of the control section: 0 to 10 percent
Clay content of particle-size control section: 4 to 18 percent
Tephra cap: The zone from 0 to 2 inches (0 to 4 centimeters) (Ay horizon)

Ay horizon:
Hue—5YR or 7.5YR
Value—3 to 5 dry; 2.5 to 4 moist
Chroma—1 to 3, dry or moist
Texture—loamy coarse sand
Clay content—4 to 12 percent
Calcium carbonate equivalent—10 to 25 percent
Gypsum content—0 to 2 percent
Rock fragments—0 to 10 percent
Reaction—moderately alkaline or strongly alkaline

2By or 2Cy horizons:
Hue—5YR or 7.5YR

Figure 163.—An area of Tsosie very gravelly coarse sand, 1 to 5 percent slopes.

Value—4 or 5 dry; 3 or 4 moist
Chroma—3 to 6, dry or moist
Texture—sandy loam, fine sandy loam, or loam
Clay content—4 to 18 percent
Calcium carbonate equivalent—10 to 25 percent
Gypsum content—0 to 5 percent
Rock fragments—0 to 10 percent
Reaction—moderately alkaline or strongly alkaline

Description of Lava Flows, Basalt

Lava flows typically have sharp, jagged surfaces, crevices, and angular blocks that are characteristic of basalt lava. Earthy material has accumulated rocks and sheltered pockets, but the flows are virtually devoid of vegetation with the exception of lichens.

120—Tsosie very gravelly coarse sand, 1 to 5 percent slopes

Map Unit Setting

Landform(s): Valley floors (fig. 163)
Elevation: 5,280 to 5,480 feet (1,610 to 1,669 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)

Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Tsosie and similar soils: 85 percent
Minor components: Peshlaki soils—10 percent; Trachute soils—5 percent

Description of the Tsosie, Tephra Soil

Taxonomic classification: Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torriorthents
Taxon kind: Series
Geomorphic position: Toeslopes beneath relict lava flows and horsts resulting from normal faulting
Parent material: Cinders derived from volcanic rock over alluvium derived from sedimentary rock
Elevation: 5,280 to 5,480 feet (1,610 to 1,669 meters)
Slope: 1 to 5 percent
Drainage class: Well drained
K_{sat} *in solum:* 0.20 inch to 99.92 inches per hour (1.40 to 705.00 micrometers per second)
Available water capacity (total inches): 10.8 (very high)
Shrink-swell potential: About 4.1 LEP (moderate)
Flooding hazard: None
Ponding hazard: None
Runoff class: High
Hydrologic group: C
Ecological site name: Loamy Upland 10-14” p.z.
Ecological site number: R035XA113AZ
Present vegetation: Galleta and fourwing saltbush
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 164)

Canopy plant cover	66
Woody debris	2
Herbaceous litter	24
Bare soil	32
Rock fragments (tephra)	25

Typical Pedon (figs. 165 through 168)

Location by Universal Transverse Mercator System: Zone 12N, 3933028 Northing, 457666 Easting

C1—0 to 1 inch (0 to 2 centimeters); black (7.5YR 2.5/1) very gravelly coarse sand, black (7.5YR 2.5/1) moist; 4 percent clay; single grain; loose, nonsticky, nonplastic; many interstitial pores; 40 percent cinders; very slightly effervescent, 1 percent calcium carbonate equivalent; slightly alkaline, pH 7.8; abrupt smooth boundary.

C2—1 to 7 inches (2 to 18 centimeters); brown (7.5YR 5/3) gravelly loam, dark brown (7.5YR 3/2) moist; 24 percent clay; moderate medium subangular blocky structure; soft, very friable, moderately sticky, moderately plastic; common very fine roots throughout; many very fine and common fine dendritic tubular pores; 20 percent cinders; very slightly effervescent, 1 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; clear smooth boundary.

Figure 164.—Surface of Tsosie very gravelly coarse sand.

2Bw—7 to 12 inches (18 to 30 centimeters); brown (7.5YR 5/3) clay loam, dark brown (7.5YR 3/2) moist; 29 percent clay; weak medium subangular blocky structure; soft, very friable, very sticky, very plastic; common very fine roots throughout; many very fine dendritic tubular pores; slightly effervescent, 3 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; gradual smooth boundary.

2Bk1—12 to 40 inches (30 to 102 centimeters); light brown (7.5YR 6/3) clay loam, dark brown (7.5YR 3/3) moist; 28 percent clay; massive; soft, very friable, very sticky, very plastic; common very fine roots throughout; common very fine dendritic tubular pores; few fine carbonate nodules in matrix and common fine carbonate filaments lining pores; slightly effervescent, 3 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; gradual smooth boundary.

2Bk2—40 to 60 inches (102 to 152 centimeters); light brown (7.5YR 6/3) clay loam, brown (7.5YR 4/3) moist; 28 percent clay; massive; slightly hard, friable, very sticky, very plastic; common very fine dendritic tubular pores; finely disseminated carbonate throughout; slightly effervescent, 3 percent calcium carbonate equivalent; moderately alkaline, pH 8.2.

Note: Table 31 shows lab data for this pedon.

Range in Characteristics

Clay content of particle-size control section: 24 to 35 percent
Tephra cap: The zone from 0 to 1 inch (0 to 2 centimeters) (C1 horizon)

C horizons:
Hue—5YR or 7.5YR

Figure 165.—Profile of Tsosie soil. Scale is in centimeters.

Value—2.5 to 5 dry; 2.5 to 3 moist
Chroma—1 to 3, dry or moist
Texture—coarse sand or loam
Clay content—4 to 35 percent
Calcium carbonate equivalent—0 to 5 percent
Organic matter content—1 to 3 percent
Rock fragments—0 to 65 percent cinders
Reaction—slightly alkaline or moderately alkaline

2Bw horizon:
Hue—7.5YR or 10YR
Value—4 or 5 dry; 3 moist
Chroma—2 or 3, dry or moist
Texture—loam, clay loam, or silty clay loam

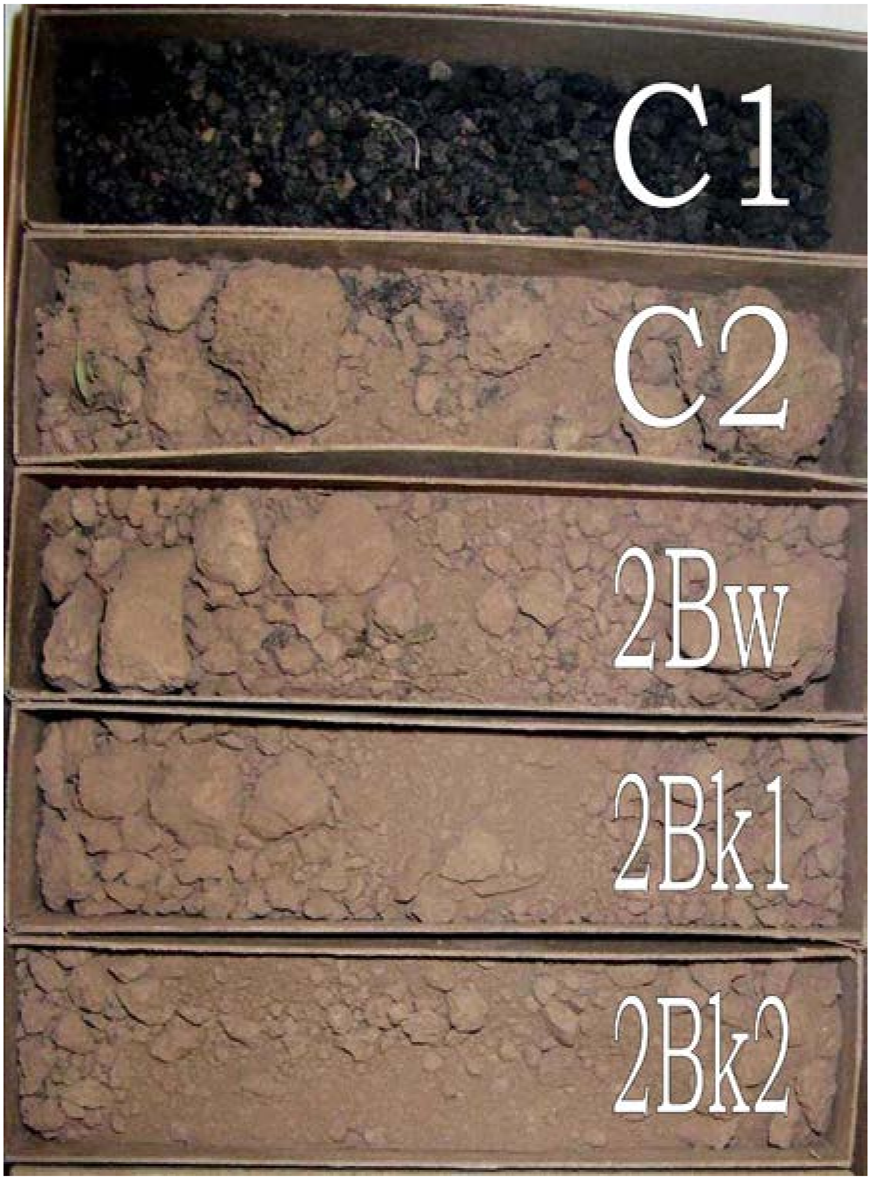


Figure 166.—Box sample of Tsosie typical pedon.

Clay content—24 to 35 percent
Calcium carbonate equivalent—2 to 15 percent
Reaction—moderately alkaline

2Bk horizons:
Hue—5YR or 7.5YR
Value—5 or 6 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Texture—clay loam, silty clay loam, or loam
Clay content—24 to 35 percent
Carbonate equivalent—2 to 15 percent
Reaction—moderately alkaline

Figure 167.—Surface sand fraction from Tsosie typical pedon.

Figure 168.—Subsurface sand fraction from Tsosie typical pedon.

Figure 169.—An area of Vitrandic Torriorthents, 10 to 63 percent slopes.

121—Vitrandic Torriorthents, 10 to 63 percent slopes

Map Unit Setting

Landform(s): Cinder cones (fig. 169)
Elevation: 5,030 to 5,590 feet (1,532 to 1,704 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 50 to 54 degrees F (10.0 to 12.0 degrees C)
Mean annual soil temperature: 52 to 56 degrees F (11.1 to 13.1 degrees C)
Frost-free period: 135 to 165 days
Major land resource area: 35—Colorado Plateau
Land resource unit: 35.1—Colorado Plateau-Mixed Grass Plains

Map Unit Composition

Vitrandic Torriorthents and similar soils: 100 percent

Description of the Vitrandic Torriorthents

Taxonomic classification: Cindery, glassy, calcareous, mesic Vitrandic Torriorthents
Taxon kind: Taxon above family
Geomorphic position: Shoulders, side slopes, and footslopes of cinder cones
Parent material: Tephra derived from volcanic rock
Elevation: 5,030 to 5,590 feet (1,532 to 1,704 meters)
Slope: 10 to 63 percent
Drainage class: Excessively drained
K_{sat} *in solum:* 5.95 to 99.92 inches per hour (42.00 to 705.00 micrometers per second)
Available water capacity (total inches): 1.9 (very low)

Figure 170.—Surface of Vitrandic Torriorthents, gravelly coarse sand, in an extremely gravelly area.

Shrink-swell potential: About 0.2 LEP (low)
Flooding hazard: None
Ponding hazard: None
Runoff class: Low
Hydrologic group: A
Ecological site name: Cinder Hills 10-14" p.z.
Ecological site number: R035XA102AZ
Present vegetation: Apache plume, buckwheat, and Cutler's jointfir
Land capability (nonirrigated areas): 6c
Surface cover (percent): (fig. 170)

Canopy plant cover	4
Woody debris	0
Herbaceous litter	4
Bare soil	0
Rock fragments (cinders)	60

Typical Pedon (figs. 171 through 174)

Location by Universal Transverse Mercator System: Zone 12N, 3933142 Northing, 464176 Easting

C—0 to 1 inch (0 to 3 centimeters); 20 percent weak red (10R 4/3) and 80 percent very dark gray (10YR 3/1) gravelly coarse sand, 20 percent dusky red (10R 3/3) and 80 percent black (10YR 2/1) moist; 2 percent clay; single grain; loose, nonsticky, nonplastic; many interstitial pores; 30 percent cinders; very slightly effervescent, 1 percent calcium carbonate equivalent; slightly alkaline, pH 7.8; clear smooth boundary.

Figure 171.—Profile of Vitrandic Torriorthents. Scale is in centimeters.

Bw—1 to 8 inches (3 to 20 centimeters); 10 percent weak red (10R 4/3) and 90 percent dark gray (10YR 4/1) gravelly loamy coarse sand, 10 percent dusky red (10R 3/3) and 90 percent black (10YR 2/1) moist; 4 percent clay; massive and weak fine granular structure; loose, nonsticky, nonplastic; many interstitial pores; 20 percent cinders; slightly effervescent, 3 percent calcium carbonate equivalent; moderately alkaline, pH 8.2; abrupt smooth boundary.

Ck—8 to 60 inches (20 to 152 centimeters); 20 percent weak red (10R 4/3) and 80 percent black (10YR 2/1) extremely gravelly coarse sand, 20 percent dusky red (10R 3/3) and 80 percent (10YR 2.5/1) moist; 2 percent clay; single grain; loose, nonsticky, nonplastic; many interstitial pores; common carbonate masses around rock fragments; 60 percent cinders; strongly effervescent, 5 percent calcium carbonate equivalent; moderately alkaline, pH 8.2.

Range in Characteristics

Note: Vitrandic Torriorthents have soil properties that vary beyond family class limits.

Rock fragment content of the control section: 35 to 90 percent cinders
Clay content of particle-size control section: 1 to 16 percent

C horizon:
Hue—5YR or 10YR
Value—2.5 to 4 dry; 2.5 or 3 moist
Chroma—1 to 3, dry or moist
Texture—coarse sand
Clay content—1 to 6 percent

Figure 172.—Box sample of Vitrandic Torriorthents typical pedon.

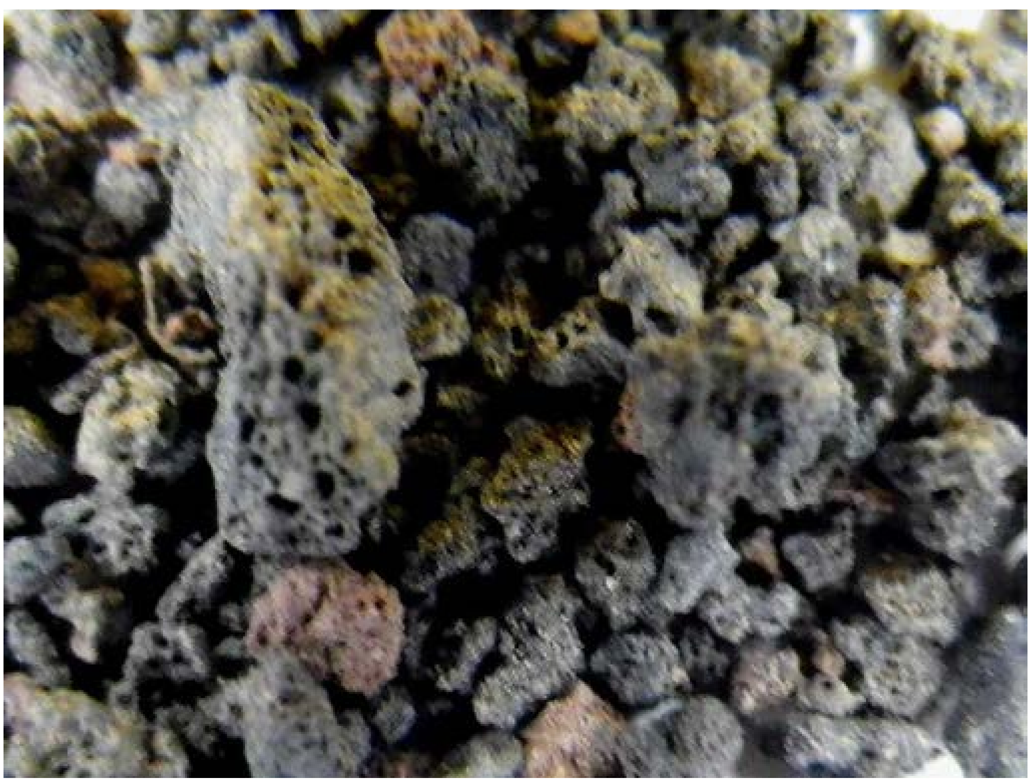


Figure 173.—Surface sand fraction from Vitrandic Torriorthents typical pedon.

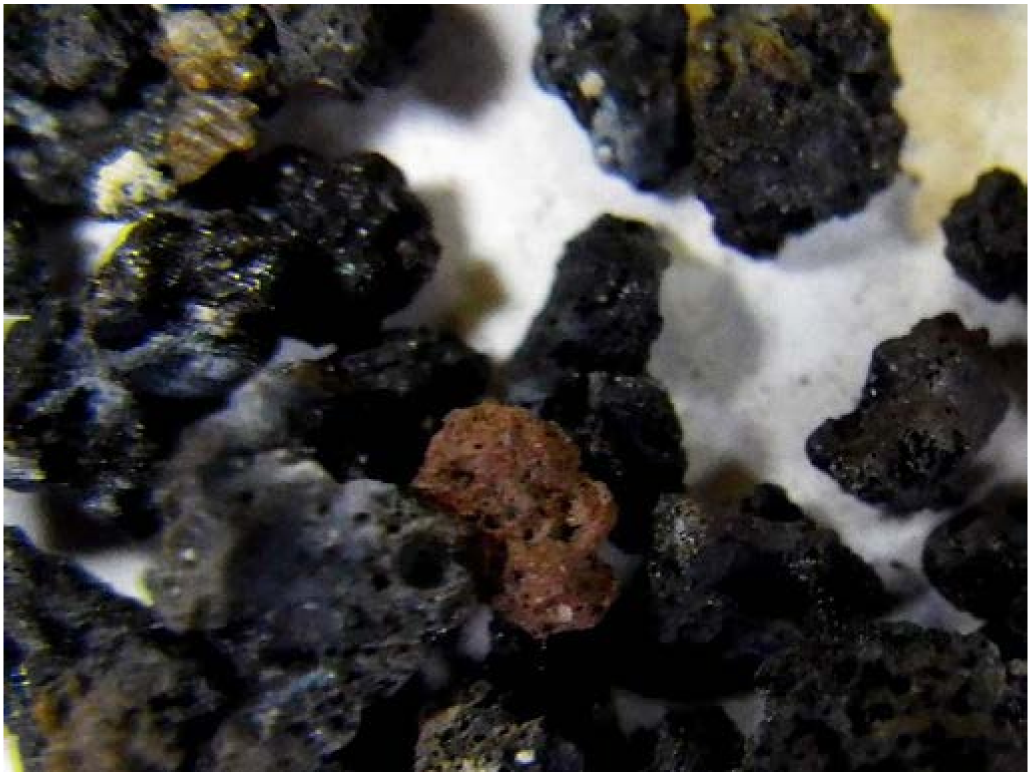


Figure 174.—Subsurface sand fraction from Vitrandic Torriorthents typical pedon.

Calcium carbonate equivalent—0 to 2 percent
Rock fragments—30 to 80 percent cinders
Reaction—slightly alkaline or moderately alkaline

Bw horizon:
Hue—5YR or 10YR
Value—2.5 to 4 dry; 2.5 or 3 moist
Chroma—1 to 4, dry or moist
Texture—loamy sand, coarse sandy loam, or loamy coarse sand
Clay content—2 to 12 percent
Calcium carbonate equivalent—2 to 5 percent
Rock fragments—10 to 40 percent cinders
Reaction—moderately alkaline or strongly alkaline

Ck horizon:
Hue—5YR or 10YR
Value—2.5 to 6 dry; 2.5 to 4 moist
Chroma—1 to 3, dry or moist
Texture—coarse sand, sandy loam, or loamy sand
Clay content—1 to 16 percent
Calcium carbonate equivalent—2 to 10 percent
Rock fragments—35 to 90 percent cinders
Reaction—moderately alkaline or strongly alkaline

Ecological Sites

Jennifer M. Putterre, ecological site inventory specialist, Natural Resources Conservation Service, prepared this section.

An *ecological site* is the product of all the environmental factors responsible for its development. It has characteristic soils that have developed over time throughout the soil formation processes; a characteristic hydrology, particularly infiltration and runoff, that has developed over time; and a characteristic plant community (kind and amount of vegetation). The hydrology of the site is influenced by development of the soil and plant community. The vegetation, soils, and hydrology are all interrelated. Each is influenced by the others and influences the development of the others. The plant community on an ecological site is typified by an association of species that differs from that of other ecological sites in the kind and/or proportion of species or in total production.

An ecological site description is a document that contains details about the characteristic soils, plant community, different ecological states and transitions that are expected, and site interpretations. For full ecological site descriptions, refer to the Natural Resources Conservation Service Ecological Site and Information System: https://esis.sc.egov.usda.gov. The ecological sites in Wupatki National Monument are briefly described in this section.

Definition of Table Headers and Discussion of Data

Table 7—Ecological Site-Soil Correlation

This table lists the map unit symbol, soil component name, and component percent with the ecological site name, ecological site type (forestland or rangeland), and ecological site ID (ecological site number).

Table 8—Climate, Landscape, Landform, Parent Material, and Ecological Site

This table displays information about climate, landscape, landform, parent material, and ecological site for each soil in the map units.

Percent of the map unit is the extent of the named soil in the map unit.

Slope is 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. The table shows the low and high range of slope for the named component or soil.

Elevation is the height of an object or area on the earth's surface in reference to a fixed reference point, such as mean sea level. The typical low and high range of elevation is displayed for each soil.

MAP is the mean annual precipitation for areas of the soil in the map unit.

Landscape refers to the broad shape of the earth in the area where the soil occurs. Examples are a valley and a mountain.

Landform is a specific shape of the earth in the area where a soil typically occurs. Examples are a mountain summit and a valley bottom.

Parent material is the material in which soils formed. Examples are the underlying geological material (including bedrock), a surficial deposit (such as volcanic ash), and organic material. Soils inherit their chemical and physical properties from the parent material.

Ecological site name and number is the ecological site name and unique reference number that are correlated to the named soil in the map unit.

Table 9—Canopy Cover

This table gives the canopy cover for the plant species associated with the map unit components. Canopy cover is determined by crown perimeter-vertical projection by species. Because this cover can overlap in layers by species, total cover can be greater than 100 percent.

Tables 10 and 11—Index of Common and Scientific Plant Names and Plant Symbols

These tables show the common plants in the survey area and their associated scientific name and plant symbol. The plants are sorted by common name in table 10 and by scientific name in table 11.

Table 12—Rangeland Ecological Sites and Characteristic Plant Communities

In areas that have similar climate and topography, differences in the kind and amount of rangeland or forest understory vegetation are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 12 lists the map unit symbol and each component's name and percent of map unit alongside the ecological site name and number; the total production of vegetation in favorable, normal, and unfavorable years; the existing vegetation (common names); and the average species composition by annual production (percent of total annual air-dry weight).

Total dry-weight production is the amount of vegetation that can be expected to grow annually on well managed rangeland and support 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 provide substantially better growing conditions 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 percentage 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. These production amounts can be used to calculate carrying capacities and stocking rates for the management of domestic or wild animals, or to determine fuel-loading in preparation of prescribed burning plans or fire modeling.

Existing vegetation includes the grasses, forbs, shrubs, and trees in the plant community at the time of the survey. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Composition gives the typical percentage of the total annual production for the dominant species of the existing vegetation.

Rangeland Ecological Sites

There are eight ecological sites in Wupatki National Monument, which can be grouped by soil moisture regimes. The park has only two moisture regimes: Ustic Aridic (MLRA 35.1) and Typic Aridic (MLRA 35.2). See the section “General Nature of the Park” for information on MLRAs.

MLRA 35.1, with the ustic aridic moisture regime, has 10 to 14 inches of precipitation annually and elevations ranging from 5,100 to 6,000 feet. Four different ecological sites occur in this area (the western half of the park), which is bounded by the Doney Cliffs. This area supports warm-season and cool-season grasses along with subdominant shrubs and scattered trees. This part of the park is typically distinguished by the presence of oneseed juniper (*Juniperus monosperma*), which is an indicator of increased effective precipitation.

MLRA 35.2, with the typic aridic moisture regime, has 6 to 10 inches of precipitation annually and elevations ranging from 3,500 to 5,500 feet. Four ecological sites occur in this area (the drier eastern half of the park). This area has sparser vegetation and tends to be treeless. Doney Cliffs are the break between moisture zones. Below these cliffs, elevation and amounts of precipitation decrease.

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 similarity index and rangeland trend. Range similarity index is determined by comparing the present plant community with the potential natural plant community on a particular rangeland ecological site. The more closely the existing community resembles the potential community, the higher the range similarity index. Rangeland trend is defined as the direction of change in an existing plant community relative to the potential natural plant community. Further information about the range similarity index and rangeland trend is available in chapter 4 of the “National Range and Pasture Handbook” (http://www.ftw.nrcs.usda.gov/glti/NRPH.html).

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, an area with a range similarity index somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

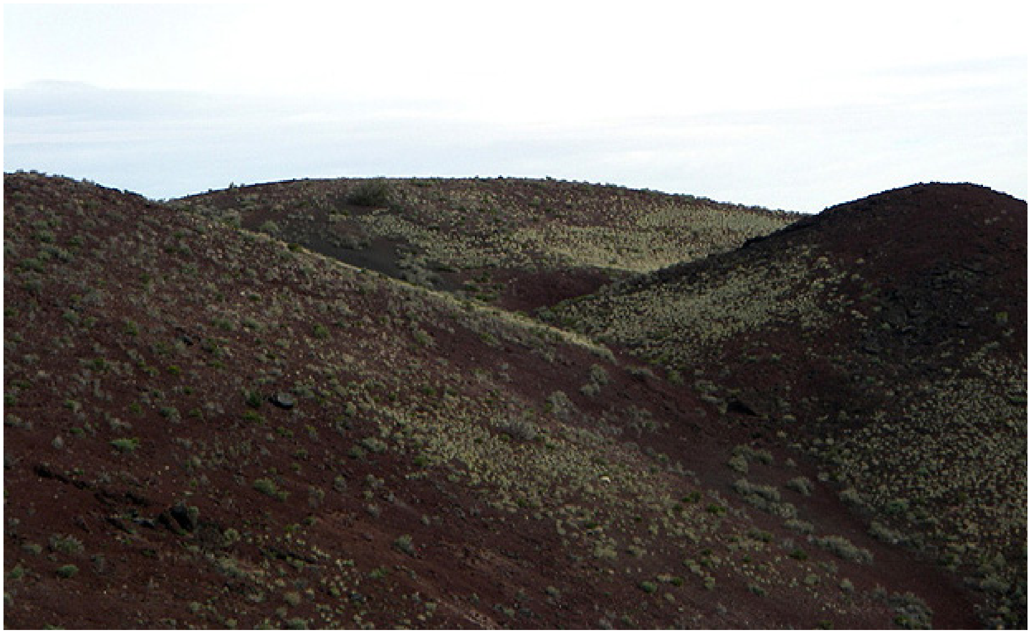


Figure 175.—Cinder Hills 10-14” p.z. (R035XA102AZ). This ecological site is part of a larger ecological site that mostly occurs outside of the park boundaries. It has limited acreage inside the park’s boundaries.

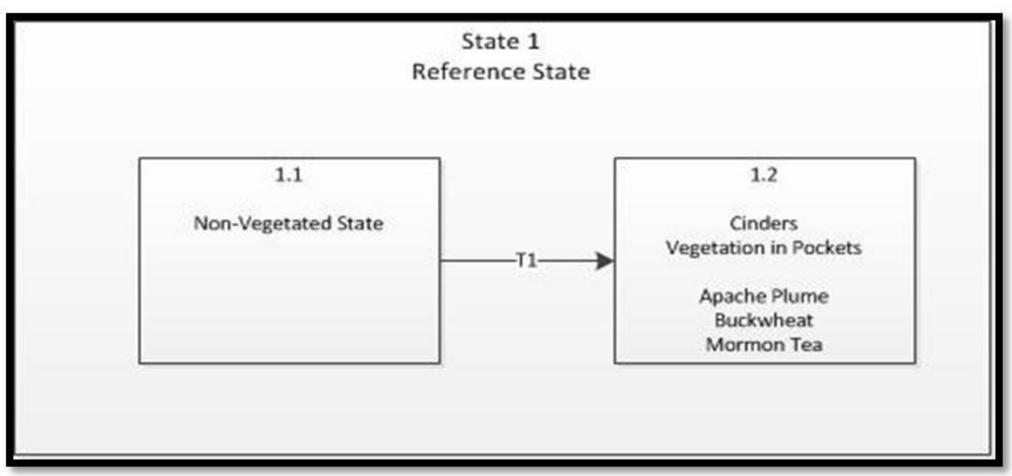


Figure 176.—State and transition model for Cinder Hills 10-14” p.z. (R035XA102AZ).

Land Resource Unit 35.1 (10–14” Precipitation Rangeland Ecological Sites)

R035XA102AZ Cinder Hills 10-14” p.z.

This ecological site occurs on cinder cones (figs. 175, 176, and 177). Soils are deep or very deep and are excessively drained. Surface layers include gravelly coarse sand as cinders and ash. Subsurface layers are cindery. The available water capacity

Ecological site name	Map unit	General location	Landform	State	Phase
Cinder Hills 10-14" p.z. (R035XA102AZ)	121	Doney Cliffs	cinder cones	1	1.2

Figure 177.—Summary of soil map units in Wupatki National Monument that occur on Cinder Hills 10-14" p.z. The state and phase columns refer to the included state and transition model.

is moderate. This site occurs at elevations between 5,026 and 5,591 feet (1,532 and 1,704 meters) on all aspects. Slopes range from 10 to 63 percent.

Mean annual precipitation ranges from 10 to 14 inches (152 to 254 millimeters), and mean annual temperature is between 54 and 57 degrees F (12 and 14 degrees C). Vegetation is sparse and tends to appear in pockets in low areas between slopes, where water tends to collect. Common vegetation on this site is Apache plume (*Fallugia paradoxa*), buckwheat (*Eriogonum* spp.) and Cutler's jointfir (*Ephedra cutleri).*

R035XA108AZ Volcanic Upland 10-14" p.z.

This ecological site occurs at the west end of the park (fig. 178 through 181). Soils range from moderately deep to very deep and from well drained to excessively drained. Surface layers include gravelly coarse sand, loamy sand, and sandy loam, typically as cinders and ash. Subsurface layers are ashy or fine-loamy. The available water capacity is moderate or high. This site occurs at elevations between 4,757 and 5,820 feet (1,450 and 1,744 meters) on all aspects. Slopes range from 0 to 18 percent.

Figure 178.—Type location for Volcanic Upland 10-14" p.z. (R035XA108AZ). The soils are moderately deep to basaltic lava flow bedrock and are considered bedrock-controlled.

Mean annual precipitation ranges from 10 to 14 inches (254 to 356 millimeters), and mean annual temperature is between 50 and 54 degrees F (10 and 12 degrees C). Dominant vegetation on this site includes James' galleta (*Pleuraphis jamesii)*, black grama (*Bouteloua eriopoda*), and scattered oneseed juniper (*Juniperus monosperma*). This site occurs on lava plains, lava flows, and ash fields.

Volcanic uplands are shallow to moderately deep to basaltic lava flows. The relict lava flows are around 2 million years old. They are covered with cinders and ash from the time of the Sunset Crater eruption.

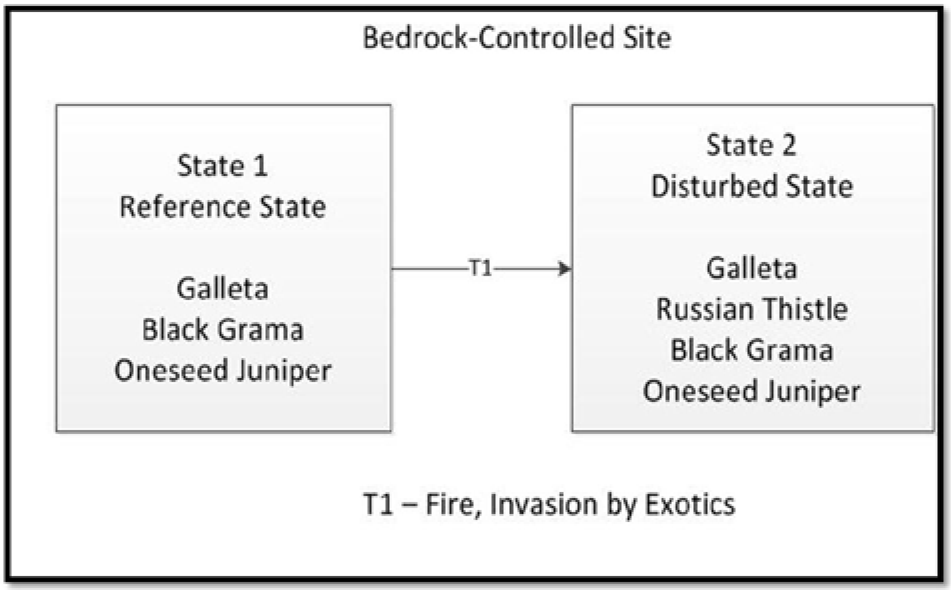


Figure 179.—State and transition model for Volcanic Upland 10-14" p.z. (R035XA108AZ).

Ecological site name	Map unit	General location	Landform	State	Phase
Volcanic Upland 10-14" p.z. (R035XA108AZ)	103	Antelope Hills	lava plains	2	1
	104	Antelope Hills and Citadel	lava plains	1	1
	101	Wupatki Basin	alluvial fans	1	1
	100	Antelope Hills	alluvial fans	2	1
	120	Citadel	valley fill and flood plains	1	1
	115	Antelope Prairie and Citadel	structural benches	1	1
	102	Antelope Prairie and Citadel	structural benches	1	1

Figure 180.—Summary of soil map units in Wupatki National Monument that occur in ecological site R035XA108AZ (Volcanic Upland 10-14" p.z.). The state and phase columns refer to the included state and transition model.

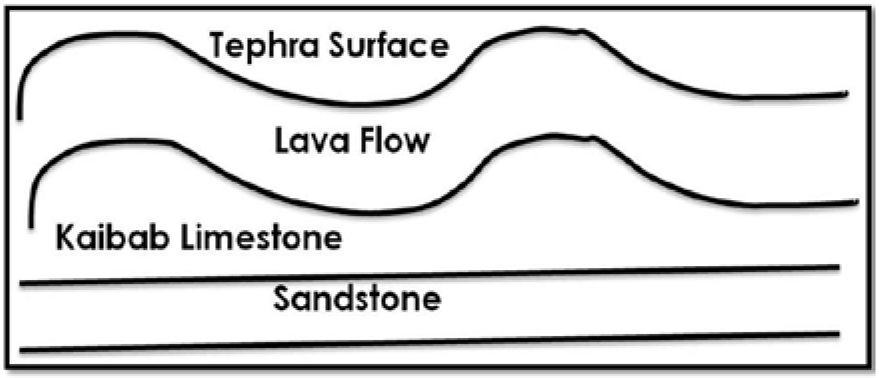


Figure 181.—Geologic representation of ecological site R035XA108AZ (Volcanic Upland 10-14” p.z.) as it occurs in Wupatki National Monument. The lava flow which is covered by the tephra flow allows for an increase in productivity. Other areas on the monument have similar sites which are not underlain by the lava flow. These other sites are considered Loamy Upland and have slightly lower productivity.

Figure 182.—Volcanic Upland 10-14” p.z. (R035XA108AZ), disturbed phase.

R035XA108AZ Volcanic Upland 10-14” p.z., Disturbed Phase

This ecological site occurs near the park boundary at Antelope Hills (fig. 182). It is part of a larger ecological site that occurs both within and outside the park boundaries. Much of this ecological site has burned recently and been invaded by Russian thistle. Antelope frequent this site.

Dominant plant species on this site are galleta (*Pleuraphis jamesii),* Russian-thistle (*Salsola kali)*, black grama (*Bouteloua eriopoda*), and oneseed juniper (*Juniperus monosperma*).

This site shows the invaded state of Russian-thistle in the blue grama-dominated site. Because it had a burn recently and is droughty, the extent of oneseed juniper has declined and that of invasive species, in particular Russian-thistle, has increased.

Figure 183.—An area of ecological site R035XA113AZ (Loamy Upland 10-14" p.z.) on lacustrine deposits covered in tephra and historically grazed. This site appears currently in state 3 but is recovering to state 1 because of the rest from grazing. This recovery is evident by the decline of fourwing saltbush (*Atriplex canescens*) and the increasing dominance of James' galleta (*Pleuraphis jamesii*).

Figure 184.—An area of ecological site R035XA113AZ (Loamy Upland 10-14" p.z.) on lacustrine deposits. This site is in state 1 and fluctuates between the three phases in that state. This site is also represented by figure 183. The two sites have similar alluvial processes and were both periodically flooded in the past. Where subjected to grazing, the site in this figure was not as affected as the site in figure 183. This site is also surrounded by the Volcanic Upland 10-14" p.z. ecological site. It is considered Loamy Upland 10-14" p.z. due to the lacustrine deposits over original limestone and sandstone parent material.

Figure 185.—An area of Loamy Upland 10-14” p.z. (R035XA113AZ). This site is in state 1, phase 1.3. The soils are very deep to bedrock and are considered alluvial-controlled.

R035XA113AZ Loamy Upland 10-14” p.z.

This ecological site occurs on alluvial fans and on lacustrine deposits at the west end of the park (figs. 183 through 189). Soils are moderately deep to very deep and well drained. In some areas this site has restrictive layers (bedrock) at a depth of 20 inches, and in other areas it has no depth restrictions. Surface layers are gravelly coarse sand, coarse sand, sand, or loamy sand, typically as cinders and ash. Subsurface layers are fine or fine-loamy. The available water capacity is moderate or high. This site occurs at elevations between 5,265 and 5,554 feet (1,605 and 1,693 meters) on all aspects. Slopes range from 0 to 3 percent.

Mean annual precipitation ranges from 10 to 14 inches (254 to 356 millimeters), and mean annual temperature is between 50 and 54 degrees F (10 and 12 degrees C). Dominant vegetation is warm- and cool-season grasses, such as Indian ricegrass (*Achnatherum hymenoides*) and James’ galleta (*Pleuraphis jamesii)* along with scattered shrubs and trees, such as fourwing saltbush (*Atriplex canescens*), rubber rabbitbrush (*Ericameria nauseosa*), and oneseed juniper (*Juniperus monosperma*).

This site is surrounded by the Volcanic Upland 10-14” p.z. ecological site (see figure 178). These areas are considered Loamy Upland 10-14” p.z. because of the flooding and alluvial deposits over the original limestone and sandstone. Historically, this site was flooded and periodically grazed. It has been rested since 1989, when the Park Service took over management and grazing permits expired.

Areas of this site are occasionally flooded. The site may have tephra covering the soil surface in some places. It has heterogeneous vegetation and low slopes, which make it appealing to herbivores, such as pronghorn antelope (*Antilocapra americana*).

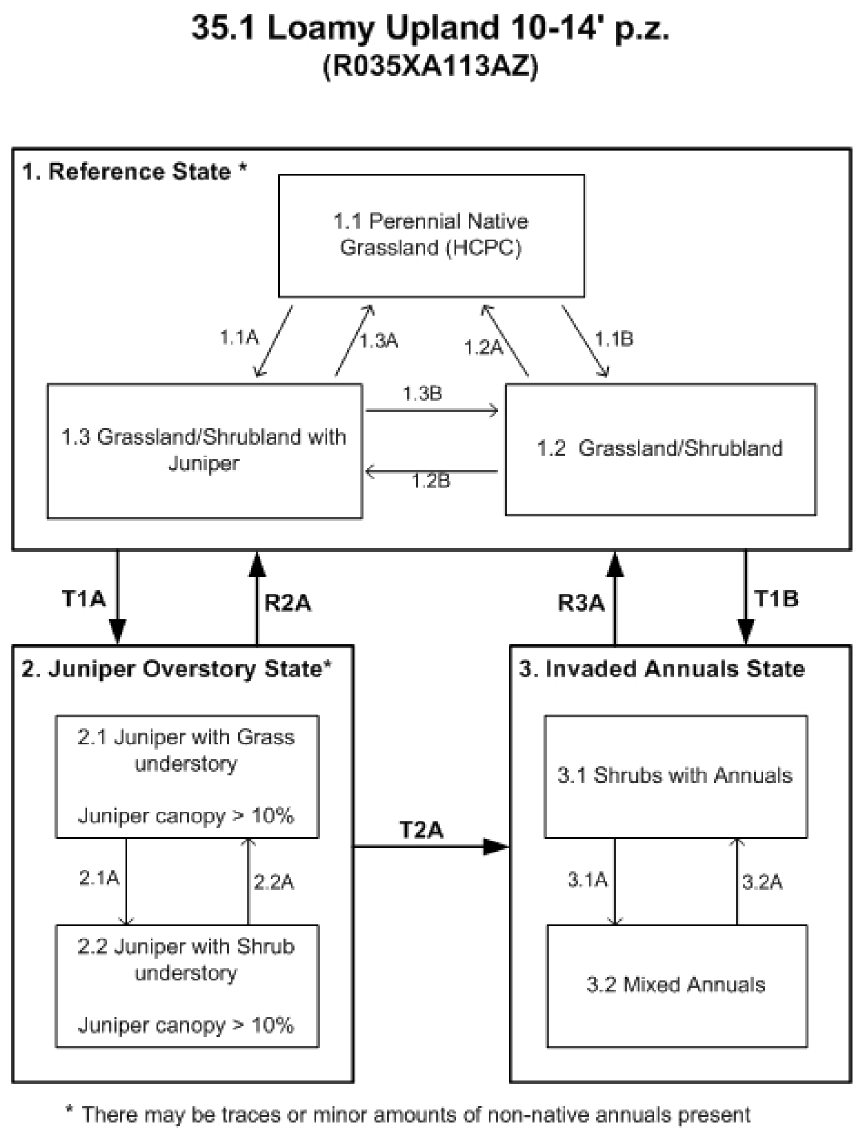


Figure 186.—Approved state and transition model for Loamy Upland 10-14" p.z. (R035XA113AZ). Not all states and phases occur within the park. This site occurs both inside and outside the park.

Ecological site name	Map unit	General location	Landform	State	Phase
Loamy Upland 10-14" p.z. (R035XA113AZ)	106	Citadel	lacustrine deposits	1	1.1, 1.2
	105	Antelope Hills	alluvial and fan terraces	1	1.3

Figure 187.—Summary of soil map units in Wupatki National Monument that occur on Loamy Upland 10-14" (R035XA113AZ) ecological site. The state and phase columns refer to the included state and transition model.

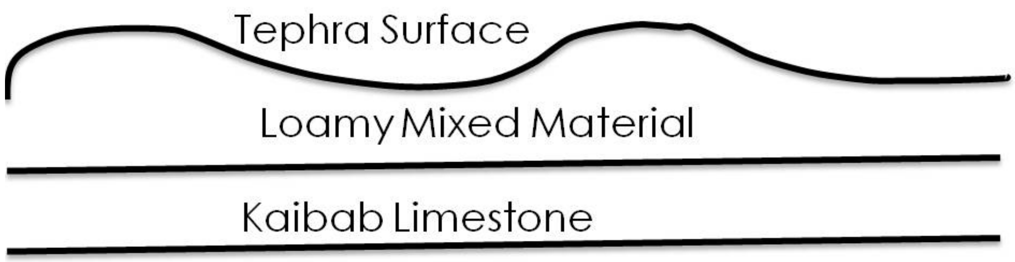


Figure 188.—Geologic representation of Loamy Upland 10-14" p.z. (R035XA113AZ) in Wupatki National Monument.

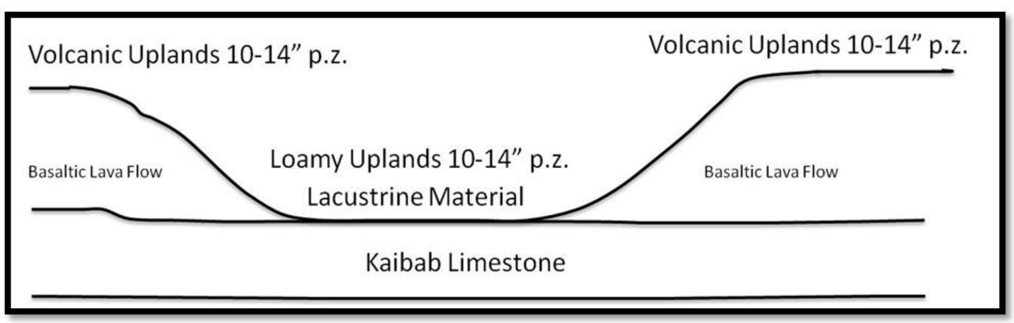


Figure 189.—Geologic representation of Loamy Upland 10-14" p.z. (R035XA113AZ), lacustrine phase.

Figure 190.—Shallow Loamy 10-14" p.z. (R035XA119AZ) ecological site, in the Doney Cliffs area in Wupatki National Monument. This ecological site is part of a larger site that occurs both inside and outside the park boundary. In the background is ecological site Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ). This site occurs in state 1 reference community and fluctuates between phases 1.1 and 1.2.

R035XA119AZ Shallow Loamy 10-14" p.z.

This ecological site occurs on Doney Cliffs, at the break between the ustic aridic moisture regime and typic aridic moisture regime (figs. 190, 191, and 192). Soils are very shallow or shallow and well drained. Surface layers include very gravelly to bouldery loamy sand, and subsurface layers are rocky and coarse. The available water capacity is low. This site is at elevations between 4,488 and 5,364 feet (1,368 and 1,635 meters). It occurs on predominantly northeast aspects. Slopes range from 7 to 68 percent.

Mean annual precipitation ranges from 10 to 14 inches (254 to 356 millimeters), and mean annual temperature is between 50 and 54 degrees F (10 and 12 degrees C). Dominant plants on this site include black grama (*Bouteloua eriopoda*), needle and thread (*Hesperostipa comata*), Cutler's jointfir (*Ephedra cutleri),* and shadscale saltbush (*Atriplex confertifolia*).

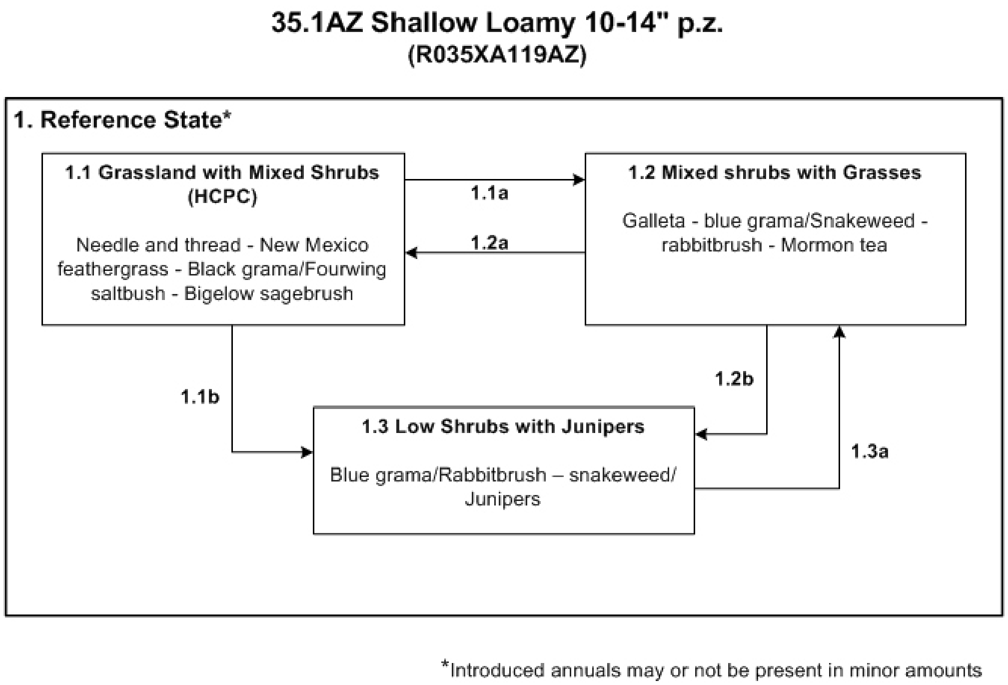


Figure 191.—Approved state and transition model for Shallow Loamy 10-14" p.z. (R035XA119AZ). This model was created to encompass a large area both inside and outside the park. Some of the states represented in this model may not occur within the park.

Ecological site name	Map unit	General location	Landform	State	Phase
Shallow Loamy 10-14" p.z. (R035XA119AZ)	108	Doney Cliffs	cliffs and canyons	1	1.1, 1.2

Figure 192.—Summary of soil map units in Wupatki National Monument that occur in the Shallow Loamy ecological site. The state and phase columns refer to the included state and transition model.

Figure 193.—Loamy Wash 6-10" p.z. (R035XB209AZ), rarely flooded phase. This site occurs in eastern part of the typic aridic section of the park. In the background is ecological site Sandstone/Shale Upland (R035XB215AZ), steep slopes phase. These sites are part of a larger ecological site that occurs both inside and outside the park boundaries. This site is in state 2, phase 2.1.

Figure 194.—An area of Loamy Wash 6-10" p.z. (R035XB209AZ) on relict stream terraces. This site is in state 3, phase 3.1. Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ) is in the background.

Figure 195.—Alternate view of Loamy Wash 6-10” p.z. (R035XB209AZ). This site is in state 3, phase 3.1. The steep slopes phase is in the background.

Land Resource Unit 35.2 (6–10” Precipitation Rangeland Ecological Sites)

R035XB209AZ Loamy Wash 6-10” p.z.

This ecological site occurs at the eastern edge of the park (figs. 193 through 197). It is dominated by alkali sacaton (*Sporobolus airoides*) and fourwing saltbush (*Atriplex canescens*). It bisects the R035XB215AZ—Sandstone/Shale Upland 6-10” p.z. site and occurs on flood plains and washes.

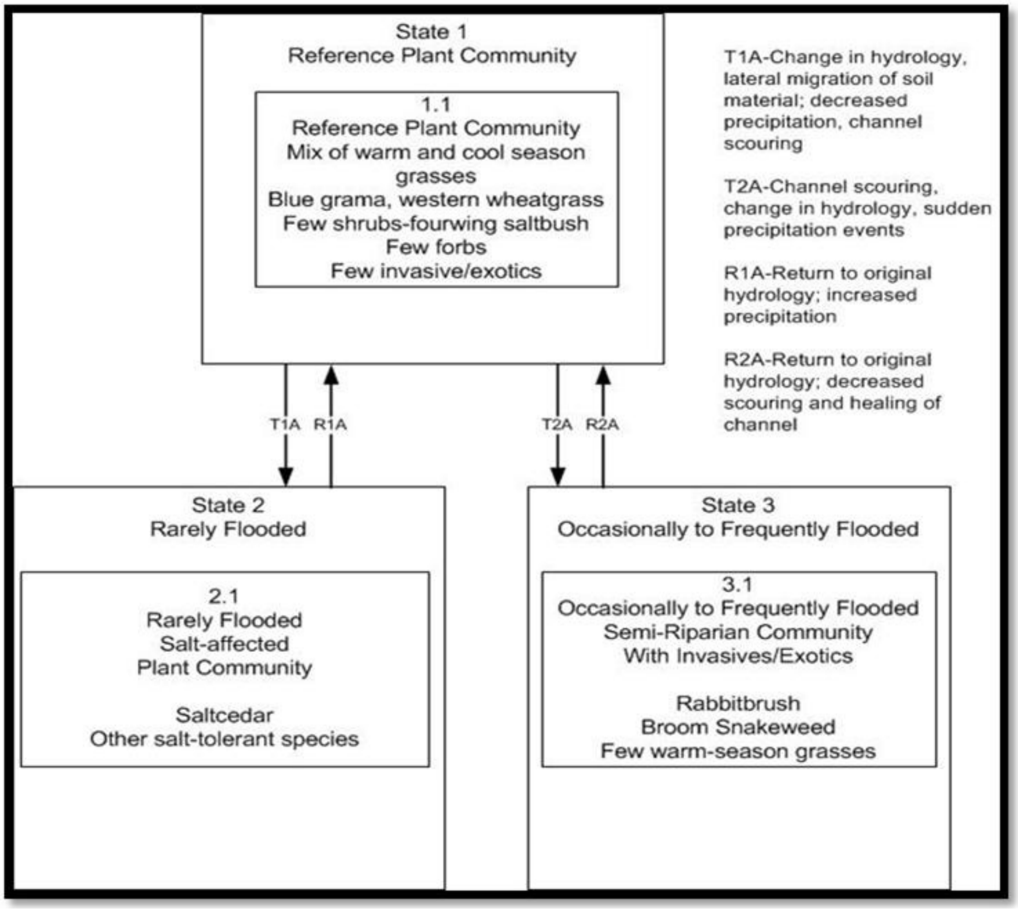


Figure 196.—State and transition model for Loamy Wash 6-10" p.z. (R035XB209AZ).

Ecological site name	Map unit	General location	Landform	State	Phase
Loamy Wash 6-10" p.z. (R035XB209AZ)	107	Wupatki Basin and Black Falls Crossing	wash bottoms	2	2.1
	107	Wupatki Basin and Black Falls Crossing	wash bottoms	3	3.1

Figure 197.—Summary of soil map units in Wupatki National Monument that occur on Loamy Wash 6-10" p.z. (R035XB209AZ). The state and phase columns refer to the included state and transition model.

Figure 198.—Loamy Upland 6-10" p.z. (R035XB210AZ). This site represents the tephra phase of a larger ecological site that occurs both inside and outside of the park boundaries.

R035XB210AZ Loamy Upland 6-10" p.z.

This ecological site occurs on the east side of the park (figs. 198, 199, and 200). Soils range from moderately deep to very deep and from well drained to excessively drained. Surface layers include coarse sand and loamy sand, typically as cinders and ash. Subsurface layers are ashy over loamy or fine-loamy material. The available water capacity is moderate or high. This ecological site occurs at elevations between 4,531 and 5,239 feet (1,381 and 1,597 meters) on all aspects. Slopes range from 0 to 45 percent. Mean annual precipitation ranges from 6 to 10 inches (152 to 254 millimeters), and mean annual temperature is between 54 and 57 degrees F (12 and 14 degrees C).

Vegetation is typically dominated by warm-season grasses, such as black grama (*Bouteloua eriopoda*), James' galleta (*Pleuraphis jamesii)*, and blue grama (*Bouteloua gracilis*), with scattered cool-season grasses. Shrubs such as fourwing saltbush (*Atriplex canescens*) and jointfir (*Ephedra* spp.) may occur on the site and may become more or less dominant (see figure 200, state 1).

This site occurs in areas of bedrock-controlled soils and areas where soils formed over bedrock. It is on climbing dunes, talus slopes, paleoterraces, dunes, and lava flows. It has various surface phases, including the tephra phase and the dune phase.

Ecological site name	Map unit	General location	Landform	State	Phase
Loamy Upland 6-10" p.z. (R035XB210AZ)	111	Wupatki Basin	climbing dunes/talus slopes	3	1
	110	Wupatki Basin	paleoterraces	3	1
	114	Wupatki Basin	lava flows	3	1
	109	Wupatki Basin	dunes	3	1
	112	Wupatiki Basin and Citadel	eolian deposits/ structural benches	3	1

Figure 199.—Summary of soil map units in Wupatki National Monument that occur in Loamy Upland 6-10" p.z. (R035XB210AZ). The state and phase columns refer to the included state and transition model.

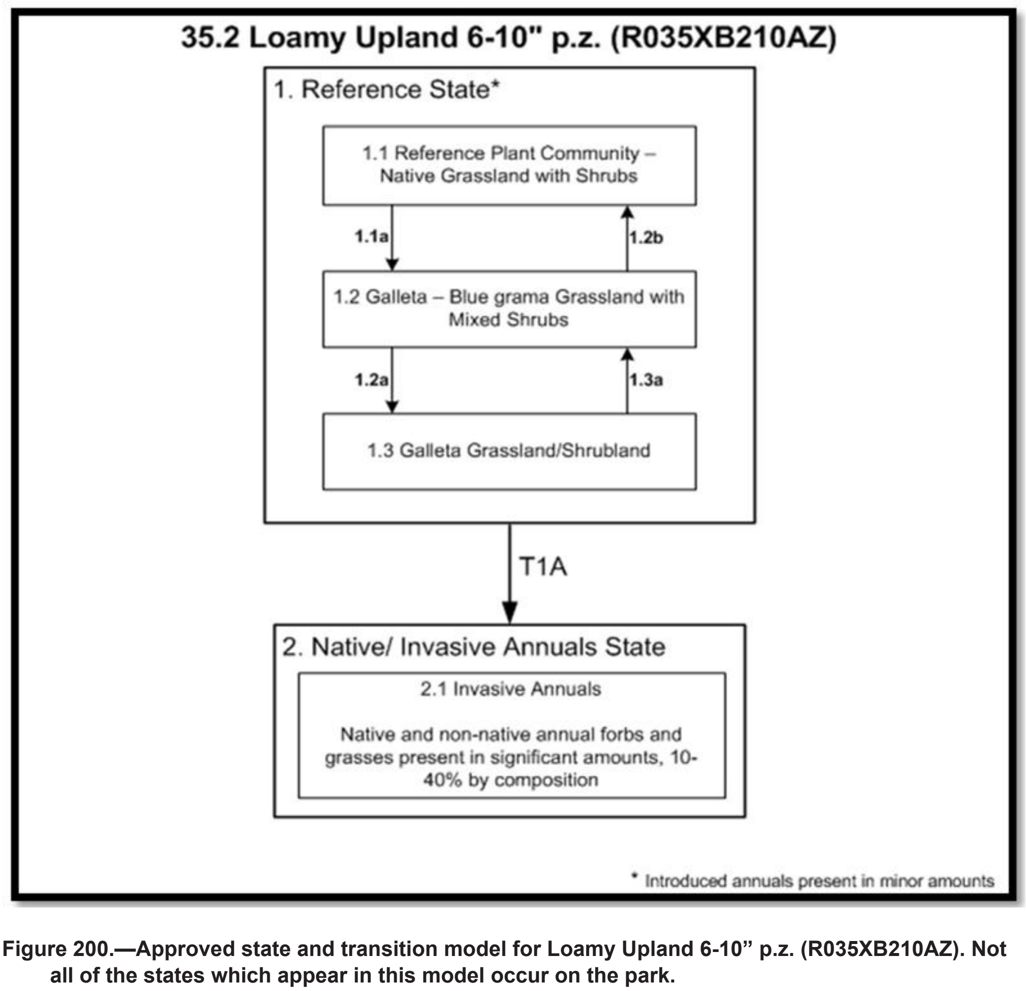


Figure 200.—Approved state and transition model for Loamy Upland 6-10" p.z. (R035XB210AZ). Not all of the states which appear in this model occur on the park.

Figure 201.—Loamy Upland 6-10” (R035XB210AZ), mixed parent materials phase.

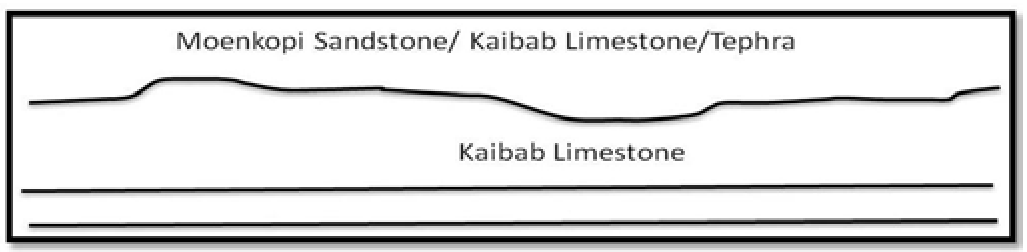


Figure 202.—Geologic representation of Loamy Uplands 6-10” p.z. (R035XB210AZ), mixed parent materials phase. The site is a mixture of materials underlain by Kaibab Limestone.

R035XB210AZ Loamy Upland 6-10”, Mixed Parent Materials Phase

In Wupatki National Monument, this ecological site is dominated by warm-season grasses, such as James’ galleta (*Pleuraphis jamesii)*, and cool-season grasses, such as Indian ricegrass (*Achnatherum hymenoides*) (fig. 201). It also has scattered shrubs. Common shrubs are rubber rabbitbrush (*Chrysothamnus* spp.) and Torrey’s jointfir (*Ephedra torreyana*). Oneseed juniper (*Juniperus monosperma*) occurs in some areas.

Soil parent material for this site is igneous tephra rock and Moenkopi Formation sandstone (fig. 202). In state 1, phase 1.2, this site may be mixed with Kaibab Formation limestone. The Moenkopi Formation is visible as mounds that periodically occur across the landscape. This formation is also dominant along road cuts in the site. This site occurs in the typic aridic regime but is in a transitional area between limestone and sandstone and the mainly sandstone material that occurs further to the east.

Figure 203.—A representative area of Loamy Upland 6-10” (R035XB210AZ), dunes phase.

R035XB210AZ Loamy Upland 6-10”, Dunes Phase

The dunes phase of Loamy Upland 6-10” (R035XB210AZ) represents a phase of this ecological site that is influenced by eolian processes (fig. 203). The vegetation is sparse and is dominated by shrubs such as buckwheat (*Eriogonum* spp.), Torrey’s jointfir (*Ephedra torreyana*), and Apache plume (*Fallugia paradoxa*). This site has colonizing herbaceous species, including sand bluestem (*Andropogon halii)* and Indian ricegrass (*Achnatherum hymenoides*).

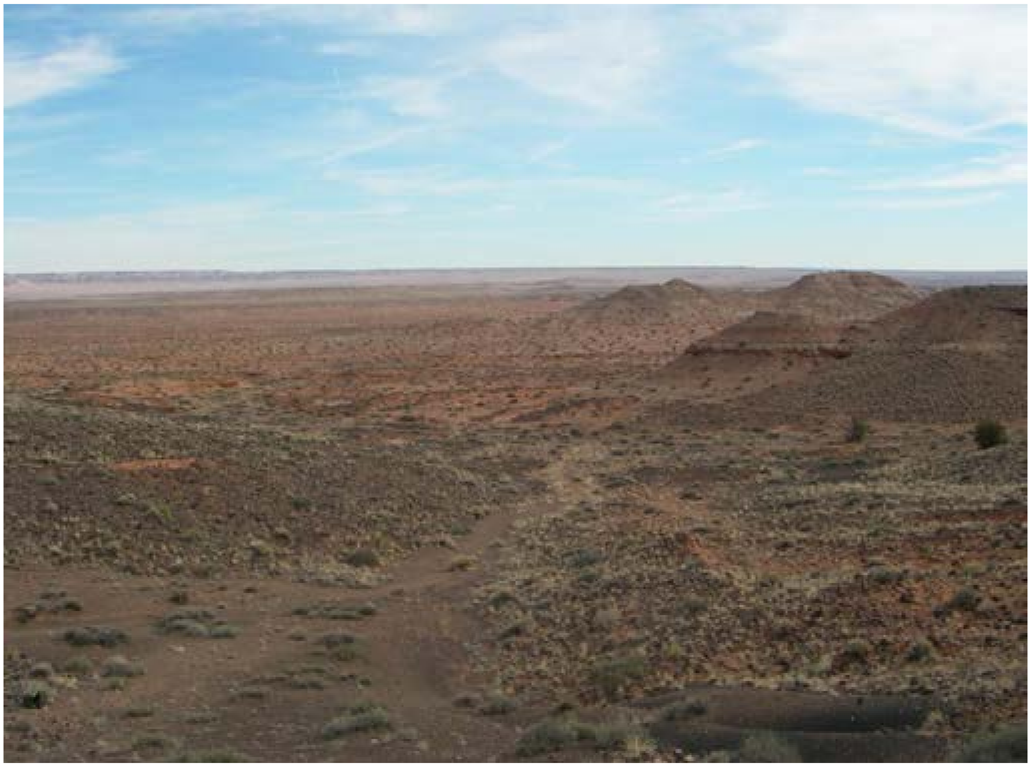


Figure 204.—Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ), steep slopes phase is in the background. Loamy Wash 6-10" p.z. (R035XB209AZ) appears in foreground as a minor component.

R035XB215AZ Sandstone/Shale Upland 6-10" p.z.

In this ecological site, soils are very shallow or shallow and well drained to excessively drained (figs. 204 through 208). Surface layers include coarse sand, sandy loam, and sandy clay loam. Subsurface layers are sandy and coarse-loamy. The available water capacity is low or moderate. This site is at elevations between 4,281 and 4,977 feet (1,305 and 1,517 meters) on all aspects. Slopes range from 1 to 40 percent. Mean annual precipitation ranges from 6 to 10 inches (152 to 254 millimeters), and mean annual temperature is between 54 and 57 degrees F (12 and 14 degrees C).

This site occurs on structural benches, stream terraces, and relict stream terraces. It is mainly in areas of bedrock-controlled soils or areas where soils formed in alluvial parent material in an erosional environment. There may be remnants of lag gravel on the summits in the steep areas and alluvial gravel on the lower terraces that have been washed down from the upper areas or deposited by the nearby wash.

Figure 205.—Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ), steep slopes. This area represents the reference state, where the site fluctuates between phases 1.1 and 1.2.

Figure 206.—Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ), gravelly phase. This site is in state 2 and probably fluctuates between the phases of state 2.

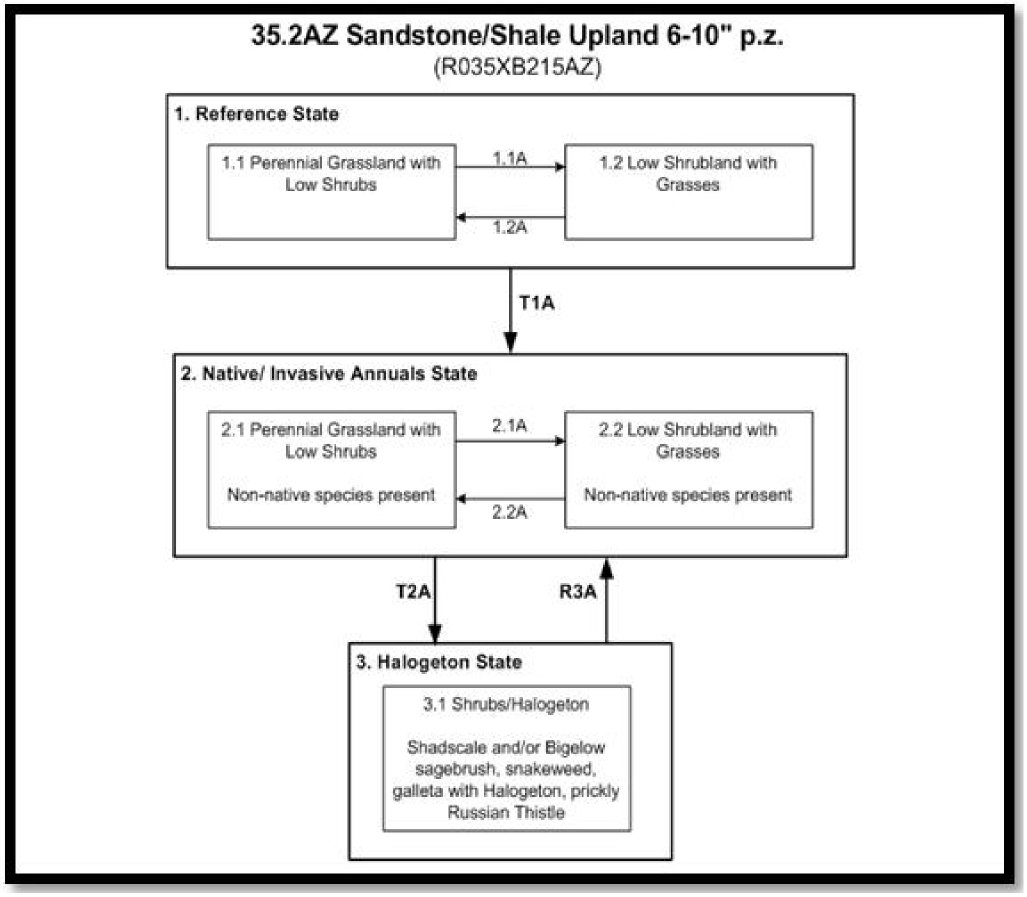


Figure 207.—General approved model for Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ). This site occurs in the park in the reference state. There are phases that occur on the park within the reference state which are not fully represented in this model.

Ecological site name	Map unit	General location	Landform	State	Phase
Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ)	112	Wupatki Basin	eolian deposits/structural benches	1	1.1, 1.2
	116	Wupatki Basin	canyons	1	1.1, 1.2
	117	Black Falls Crossing	cliffs, cuestas, and scarp slopes	1	1.1, 1.2
	118	Wupatki Basin and Black Falls Crossing	cliffs, cuestas, and scarp slopes	1	1.1, 1.2
	113	Wupatiki Basin and Black Falls Crossing	structural benches	1	1.1, 1.2

Figure 208.—Summary of soil map units in Wupatki National Monument that occur on Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ). The state and phase columns refer to the included state and transition model.

Figure 209.—Basalt Upland 6-10" p.z. (R035XB231AZ). This site occurs near Black Falls Crossing, at the eastern edge of the park, on basin floor remnants. It is dominated by alkali sacaton (*Sporobolus airoides*) and James' galleta (*Pleuraphis jamesii)*. It is part of a larger ecological site that occurs both inside and outside the park boundaries. This figure shows state 1, phase 1.1.

Figure 210.—Alternate view of Basalt Upland 6-10" p.z. (R035XB231AZ), reference site. Alkali sacaton (*Sporobolus airoides*) dominates, and shrubs such as jointfir (*Ephedra* spp.) and fourwing saltbush (*Atriplex canescens*) are subdominant. This site is in state 1, phase 1.1a.

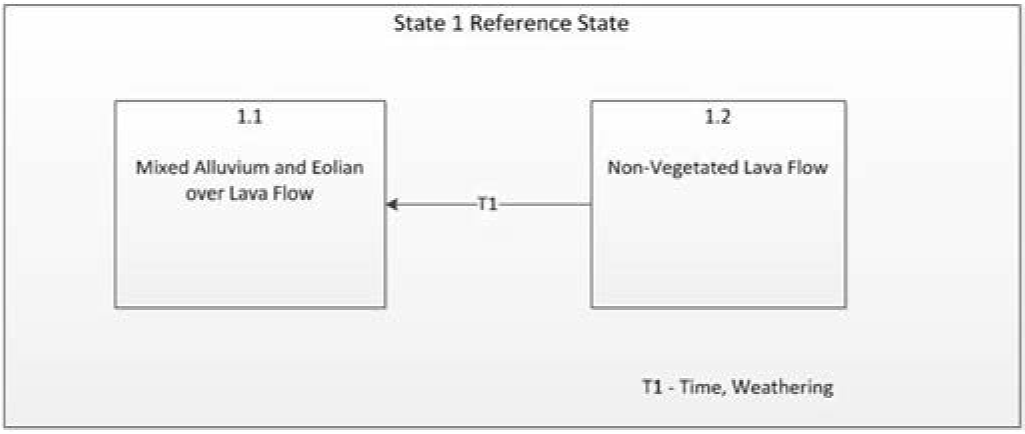


Figure 211.—State and transition model for Basalt Upland 6-10” p.z. (R035XB231AZ).

Ecological site name	Map unit	General location	Landform	State	Phase
Basalt Upland 6-10” p.z. (R035XB231AZ)	119	Black Falls Crossing	terrace deposits over lava flow	1	1.1

Figure 212.—Summary of soil map units in Wupatki National Monument that occur in Basalt Upland 6-10” p.z. (R035XB231AZ). The state and phase columns refer to the included state and transition model.

R035XB231AZ Basalt Upland 6-10” p.z.

In this ecological site, soils are deep or very deep and somewhat excessively drained (figs. 209 through 212). Surface layers include loamy coarse sand and sandy loam. Subsurface layers are coarse-loamy. The available water capacity is moderate. This site occurs at elevations between 4,285 and 4,341 feet (1,306 and 1,323 meters) on all aspects. Slopes range from 0 to 5 percent. Mean annual precipitation ranges from 6 to 10 inches (152 to 254 millimeters), and mean annual temperature is between 54 and 57 degrees F (12 and 14 degrees C). This site is dominated by warm-season grasses, including alkali sacaton (*Sporobolus airoides*) and James’ galleta (*Pleuraphis jamesii)*.

This site occurs on basin floor remnants and originated from stream deposits and reworked alluvium. Lava flowed over the site, and then the site was occasionally flooded by the Little Colorado River. Over time, eolian deposits and alluvial deposits have contributed to the site, giving it a “mixed material volcanic” parent material. This is considered a volcanic-bedrock-controlled site.

Ecological site name	Ecological site number	MLRA	LRU/CRA	Moisture regime
Basalt Upland 6-10" p.z.	R035XB231AZ	35	35.2	typic aridic
Cinder Hills 10-14" p.z.	R035XA102AZ	35	35.1	ustic aridic
Loamy Upland 10-14" p.z.	R035XA113AZ	35	35.1	ustic aridic
Loamy Upland 6-10" p.z.	R035XB210AZ	35	35.2	typic aridic
Loamy Wash 6-10" p.z.	R035XB209AZ	35	35.2	typic aridic
Sandstone/Shale Upland 6-10" p.z.	R035XB215AZ	35	35.2	typic aridic
Shallow Loamy 10-14" p.z.	R035XA119AZ	35	35.1	ustic aridic
Volcanic Upland 10-14" p.z.	R035XA108AZ	35	35.1	ustic aridic

Figure 213.—Summary of ecological site names and numbers for Wupatki National Monument.

Summary and Conclusions

Wupatki National Monument had eight ecological sites. The sites were assigned based on rainfall, soil moisture, geology, landform, soil depth, vegetation production, and plant species composition (see figures 213, 214, and 215). They can be grouped by soil moisture regimes.

Ustic Aridic Moisture Regime

R035XA108AZ—Volcanic Upland 10-14” p.z. differs from R035XA113AZ—Loamy Upland 10-14” p.z. in that it includes areas with lava flow under cinders. The lava flow on the Volcanic Upland site allows for increased productivity because weathering of the lava flow increases the amount of plant-available nutrients.

R035XA113AZ—Loamy Upland 10-14” p.z. occurs in alluvial and lacustrine areas of the park that may resemble R035XA108AZ—Volcanic Upland 10-14” p.z. superficially. These sites may be covered in tephra or patchy tephra and may have characteristics or evidence of past flooding. Slopes are generally low on these sites, and plant biomass is generally lower on these sites than on the Volcanic Upland sites.

R035XA119AZ—Shallow Loamy 10-14” p.z. occurs on the Doney Cliffs limestone in Wupatki National Monument. This area is considered the dividing line between precipitation zones in the park.

R035XA102AZ—Cinder Hills 10-14” p.z is only on the partial Doney Mountain cinder cone that occurs along the park boundary.

Typic Aridic Moisture Regime

R035XB210AZ—Loamy Upland 6-10” p.z. is similar to R035XA113AZ Loamy Upland 10-14” p.z. Because this site occurs in a lower rainfall zone, it has more drought-tolerant plants. Reworked alluvium and eolian material over Kaibab Formation limestone are the parent materials for this site.

Ecological site name	Associated map units
Ustic Aridic (West End of Park)	
Volcanic Upland 10-14” p.z. (R035XA108AZ)	100, 101, 102, 103, 104, 115, 120
Loamy Upland 10-14” p.z. (R035XA113AZ)	105, 106
Shallow Loamy 10-14” p.z. (R035XA119AZ)	108
Cinder Hills 10-14” p.z. (R035XA102AZ)	121
Typic Aridic (East End of Park)	
Loamy Upland 6-10” p.z. (R035XB210AZ)	109, 110, 111, 112, 114
Sandstone/Shale Upland 6-10” p.z. (R035XB215AZ)	112, 113, 116, 117, 118
Basalt Upland 6-10” p.z. (R035XB231AZ)	119
Loamy Wash 6-10” p.z. (R035XB209AZ)	107

Figure 214.—Ecological sites and associated map units.

Ecological site name	Type of parent material
Ustic Aridic (West End of Park)	
Volcanic Upland 10-14” p.z. (R035XA108AZ)	Bedrock
Loamy Upland 10-14” p.z. (R035XA113AZ)	Alluvial/lacustrine/deep to bedrock
Shallow Loamy 10-14” p.z. (R035XA119AZ)	Bedrock
Cinder Hills 10-14” p.z. (R035XA102AZ)	Bedrock
Typic Aridic (East End of Park)	
Loamy Upland 6-10” p.z. (R035XB210AZ)	Alluvial/deep to bedrock
Sandstone/Shale Upland 6-10” p.z. (R035XB215AZ)	Bedrock
Basalt Upland 6-10” p.z. (R035XB231AZ)	Bedrock
Loamy Wash 6-10” p.z. (R035XB209AZ)	Alluvial

Figure 215.—Summary of ecological sites and type of parent material.

R035XB215AZ—Sandstone/Shale Upland 6-10” p.z. appears on the red hills eroded from Moenkopi Formation sandstone and in washes at the drier end of the park.

R035XB231AZ—Basalt Upland 6-10” p.z. occurs at the drier end of the park where mixed alluvium and eolian material occur on the old flood plains of the Little Colorado River. This site has mounds of basaltic lava flows scattered throughout. These areas have extensive mixing of materials due to the variety of processes occurring on this site.

R035XB209AZ—Loamy Wash 6-10” p.z. occurs at the drier end of the park on flood plains and in washes. This site bisects R035XB215AZ Sandstone/Shale Upland 6-10” p.z. and occurs on Deadman Wash in Wupatki National Monument.

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 forestland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and as 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.

Interpretive Ratings

The interpretive tables in this survey rate the soils in the survey area for various uses. Many of the tables identify the limitations that affect specified uses and indicate the severity of those limitations. The ratings in these tables are both verbal and numerical.

Rating Class Terms

Rating classes are expressed in the tables in terms that indicate the extent to which the soils are limited by all of the soil features that affect a specified use or in terms that indicate the suitability of the soils for the use. Thus, the tables may show limitation classes or suitability classes. Terms for the limitation classes are *not limited, somewhat limited,* and *very limited*. The suitability ratings are expressed as *well suited, moderately suited, poorly suited,* and *unsuited* or as *good, fair,* and *poor*.

Numerical Ratings

Numerical ratings in the tables indicate the relative severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.00 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use and the point at which the soil feature is not a limitation. The limitations appear in order from the most limiting to the least limiting. Thus, if more than one limitation is identified, the most severe limitation is listed first and the least severe one is listed last.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. 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 forestland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit (USDA-SCS, 1961).

Capability classes, the broadest groups, are designated by the numbers 1 through 8. The numbers indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class 1 soils have slight limitations that restrict their use.

Class 2 soils have moderate limitations that restrict the choice of plants or that require moderate conservation practices.

Class 3 soils have severe limitations that restrict the choice of plants or that require special conservation practices, or both.

Class 4 soils have very severe limitations that restrict the choice of plants or that require very careful management, or both.

Class 5 soils are subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.

Class 6 soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.

Class 7 soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.

Class 8 soils and miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or esthetic purposes.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, 2e. 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 1 there are no subclasses because the soils of this class have few limitations. Class 5 contains only the subclasses indicated by *w, s,* or *c* because the soils in class 5 are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, forestland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, 2e-4 and 3e-6. These units are not given in all soil surveys.

The capability classification of map units in this survey area is given in table 13 and in the section “Detailed Soil Map Units.”

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, forestland, 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. 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.

There are no areas in the Wupatki National Monument that meet the soil requirements for prime farmland.

Hydric Soils

There are no hydric soils in the survey area. This section is provided for informational purposes.

The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin and others, 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985). Criteria for all of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands. Onsite investigation is recommended to determine the hydric soils on a specific site (National Research Council, 1995; USDA-NRCS, 2010).

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in “Soil Taxonomy” (Soil Survey Staff, 1999) and “Keys to Soil Taxonomy” (Soil Survey Staff, 2010) and in the “Soil Survey Manual” (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in “Field Indicators of Hydric Soils in the United States” (USDA-NRCS, 2010).

Hydric soils are identified by examining and describing the soil to a depth of about 20 inches. This depth may be greater if determination of an appropriate indicator so requires. It is always recommended that soils be excavated and described to the depth necessary for an understanding of the redoximorphic processes. Then, using the completed soil descriptions, soil scientists can compare the soil features required by each indicator and specify which indicators have been matched with the conditions observed in the soil. The soil can be identified as a hydric soil if at least one of the approved indicators is present.

Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform.

Land Management

In table 14, parts I through IV, interpretive ratings are given for various aspects of land management. The ratings are both verbal and numerical.

Some rating class terms indicate the degree to which the soils are suited to a specified land management practice. *Well suited* indicates that the soil has features that are favorable for the specified practice and has no limitations. Good performance can be expected, and little or no maintenance is needed. *Moderately suited* indicates that the soil has features that are moderately favorable for the specified practice. One or more soil properties are less than desirable, and fair performance can be expected. Some maintenance is needed. *Poorly suited* indicates that the soil has one or more properties that are unfavorable for the specified practice. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration. *Unsuited* indicates that the expected performance of the soil is unacceptable for the specified practice or that extreme measures are needed to overcome the undesirable soil properties.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified land management practice (1.00) and the point at which the soil feature is not a limitation (0.00).

Rating class terms for *fire damage* and *seedling mortality* are expressed as low, moderate, and high. Where these terms are used, the numerical ratings indicate gradations between the point at which the potential for fire damage or seedling mortality is highest (1.00) and the point at which the potential is lowest (0.00).

Rating class terms for *hazard of erosion* are expressed as slight, moderate, severe, and very severe. Where these terms are used, the numerical ratings indicate gradations between the point at which the potential for erosion is highest (1.00) and the point at which the potential is lowest (0.00).

The paragraphs that follow indicate the soil properties considered in rating the soils for land management practices.

Planting

Ratings in the columns *suitability for hand planting* and *suitability for mechanical planting* are based on slope, depth to a restrictive layer, content of sand, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, moderately suited, poorly suited, or unsuited to these methods of planting. It is assumed that necessary site preparation is completed before seedlings are planted.

Ratings in the column *suitability for use of harvesting equipment* indicate the suitability of the soils for harvesting with heavy equipment. It assumes the use of standard rubber-tired skidders and bulldozers for ground-based harvesting and transport. It considers the off-road transport or harvest of logs and/or wood products by ground-based wheeled or tracked equipment. Activities that disturb from 35 to 75 percent of the surface area with rutting, puddling, or displacement up to a depth of 18 inches are considered. Year-round water tables and year-round ponding are unfavorable. Ratings do not assess non-soil obstacles, such as slash, or frozen or snow-covered soils.

Hazard of Erosion and Suitability for Roads

Ratings in the column *hazard of erosion* are based on slope and on soil erodibility factor K. The soil loss is caused by sheet or rill erosion in areas where 50 to 75 percent of the surface has been exposed by different kinds of disturbance. The hazard is described as slight, moderate, severe, or very severe. A rating of *slight* indicates that erosion is unlikely under ordinary climatic conditions; *moderate* indicates that some erosion is likely and that erosion-control measures may be needed; *severe* indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and *very severe* indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Ratings in the column *hazard of erosion on roads and trails* are based on the soil erodibility factor K, slope, and content of rock fragments. The ratings apply to unsurfaced roads and trails. The hazard is described as slight, moderate, or severe. A rating of *slight* indicates that little or no erosion is likely; *moderate* indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and *severe* indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed.

Ratings in the column *suitability for roads (natural surface)* are based on slope, rock fragments on the surface, plasticity index, content of sand, the Unified classification, depth to a water table, ponding, flooding, and the hazard of soil slippage. The ratings indicate the suitability for using the natural surface of the soil for roads. The soils are described as well suited, moderately suited, or poorly suited to this use.

Site Preparation

Ratings in the column *suitability for mechanical site preparation (deep)* are based on slope, depth to a restrictive layer, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, poorly suited, or unsuited to this management activity. The part of the soil from the surface to a depth of about 3 feet is considered in the ratings.

Ratings in the column *suitability for mechanical site preparation (surface)* are based on slope, depth to a restrictive layer, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, poorly suited, or unsuited to this management activity. The part of the soil from the surface to a depth of about 1 foot is considered in the ratings.

Site Restoration

Ratings in the column *potential for damage to soil by fire* are based on texture of the surface layer, content of rock fragments and organic matter in the surface layer, thickness of the surface layer, and slope. The soils are described as having a low, moderate, or high potential for this kind of damage. The ratings indicate an evaluation of the potential impact of prescribed fires or wildfires that are intense enough to remove the duff layer and consume organic matter in the surface layer.

Ratings in the column *potential for seedling mortality* are based on flooding, ponding, depth to a water table, content of lime, reaction, salinity, available water capacity, soil moisture regime, soil temperature regime, aspect, and slope. The soils are described as having a low, moderate, or high potential for seedling mortality.

Recreation

The soils of the park are rated in table 15, parts I and II, according to limitations that affect their suitability for recreation. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings in the table 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 also are important. Soils that are 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.

The information in table 15 can be supplemented by other information in this survey, for example, interpretations for building site development, construction materials, and water management.

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 ratings are based on the soil properties that affect the ease of developing camp areas and the performance of the areas after development. Slope, stoniness, and depth to bedrock or a cemented pan are the main concerns affecting the development of camp areas. The soil properties that affect the performance of the areas after development are those that influence trafficability and promote the growth of vegetation, especially in heavily used areas. For good trafficability, the surface of camp areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The ratings are based on the soil properties that affect the ease of developing picnic areas and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of picnic areas. For good trafficability, the surface of picnic areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Foot traffic and equestrian trails for hiking and horseback riding should require little or no slope modification through cutting and filling. The ratings are based on the soil properties that affect trafficability and erodibility. These properties are stoniness, depth to a water table, ponding, flooding, slope, and texture of the surface layer.

Mountain bike and off-road vehicle trails require little or no site preparation. They are not covered with surfacing material or vegetation. Considerable compaction of the soil material is likely. The ratings are based on the soil properties that influence erodibility, trafficability, dustiness, and the ease of revegetation. These properties are stoniness, depth to a water table, ponding, slope, flooding, and texture of the surface layer.

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 data in the tables described under the heading "Soil Properties."

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 between the surface and a depth of 5 to 7 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 particle-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 7 feet of the surface, soil wetness, depth to a water table, ponding, 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.

Dwellings and Small Commercial Buildings

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. Table 16 shows the degree and kind of soil limitations that affect dwellings and small commercial buildings.

The ratings in the table are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Dwellings are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of about 7 feet. The ratings for dwellings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Compressibility is inferred from the Unified classification. The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Small commercial buildings are structures that are less than three stories high and do not have basements. The foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. The ratings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (which is inferred from the Unified classification). The properties that affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Roads and Streets, Shallow Excavations, and Landscaping

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. Table 17 shows the degree and kind of soil limitations that affect local roads and streets, shallow excavations, and landscaping.

The ratings in the table are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a surface of flexible material (asphalt), rigid material (concrete), or gravel with a binder. The ratings are based on the soil properties that affect the ease of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, depth to a water table, ponding, flooding, the amount of large stones, and slope. The properties that affect the traffic-supporting capacity are soil strength (as inferred from the AASHTO group index number), subsidence, linear extensibility (shrink-swell potential), the potential for frost action, depth to a water table, and ponding.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting. Depth to the seasonal high water table, flooding, and ponding may restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and linear extensibility (shrink-swell potential) influence the resistance to sloughing.

Landscaping requires soils on which turf, trees, and shrubs can be established and maintained. Irrigation is not considered in the ratings. The ratings are based on the soil properties that affect plant growth and trafficability after vegetation is established. The properties that affect plant growth are reaction; depth to a water table; ponding; depth to bedrock or a cemented pan; the available water capacity in the upper 40 inches; the content of salts, sodium, or calcium carbonate; and sulfidic materials. The properties that affect trafficability are flooding, depth to a water table, ponding, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer.

Sewage Disposal

Table 18 shows the degree and kind of soil limitations that affect septic tank absorption fields and sewage lagoons. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. Saturated hydraulic conductivity (K_{sat}), depth to a water table, ponding, depth to bedrock or a cemented pan, and flooding affect absorption of the effluent. Stones and boulders, ice, and bedrock or a cemented pan interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the distribution lines. In these soils the absorption field may not adequately filter the effluent, particularly when the system is new. As a result, the ground water may become contaminated.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Considered in the ratings are slope, saturated hydraulic conductivity (K_{sat}), depth to a water table, ponding, depth to bedrock or a cemented pan, flooding, large stones, and content of organic matter.

Saturated hydraulic conductivity (K_{sat}) is a critical property affecting the suitability for sewage lagoons. Most porous soils eventually become sealed when they are used as sites for sewage lagoons. Until sealing occurs, however, the hazard of pollution is severe. Soils that have a K_{sat} rate of more than 14 micrometers per second are too porous for the proper functioning of sewage lagoons. In these soils, seepage of the effluent can result in contamination of the ground water. Ground-water contamination is also a hazard if fractured bedrock is within a depth of 40 inches, if the water table is high enough to raise the level of sewage in the lagoon, or if floodwater overtops the lagoon.

A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor. If the lagoon is to be uniformly deep throughout, the slope must be gentle enough and the soil material must be thick enough over bedrock or a cemented pan to make land smoothing practical.

Source of Gravel and Sand

Table 19 gives information about the soils as potential sources of gravel and sand. Normal compaction, minor processing, and other standard construction practices are assumed.

Gravel and *sand* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. Only the likelihood of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material. The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the Unified classification of the soil), the thickness of suitable material, and the content of rock fragments. If the bottom layer of the soil contains sand or gravel, the soil is considered a likely source regardless of thickness. The assumption is that the sand or gravel layer below the depth of observation exceeds the minimum thickness. The ratings are for the whole soil, from the surface to a depth of about 6 feet.

The soils are rated *good, fair,* or *poor* as potential sources of sand and gravel. A rating of *good* or *fair* means that the source material is likely to be in or below the soil. The bottom layer and the thickest layer of the soils are assigned numerical ratings. These ratings indicate the likelihood that the layer is a source of sand or gravel. The number 0.00 indicates that the layer is a poor source. The number 1.00 indicates that the layer is a good source. A number between 0.00 and 1.00 indicates the degree to which the layer is a likely source.

Source of Reclamation Material, Roadfill, and Topsoil

Table 20 gives information about the soils as potential sources of reclamation material, roadfill, and topsoil. Normal compaction, minor processing, and other standard construction practices are assumed.

The soils are rated *good, fair,* or *poor* as potential sources of reclamation material, roadfill, and topsoil. The features that limit the soils as sources of these materials are specified in the table. Numerical ratings between 0.00 and 0.99 are given after the specified features. These numbers indicate the degree to which the features limit the soils as sources of topsoil, reclamation material, or roadfill. The lower the number, the greater the limitation.

Reclamation material is used in areas that have been drastically disturbed by surface mining or similar activities. When these areas are reclaimed, layers of soil material or unconsolidated geological material, or both, are replaced in a vertical sequence. The reconstructed soil favors plant growth. The ratings in the table do not apply to quarries and other mined areas that require an offsite source of reconstruction material. The ratings are based on the soil properties that affect erosion and stability of the surface and the productive potential of the reconstructed soil. These properties include the content of sodium, salts, and calcium carbonate; reaction; available water capacity; erodibility; texture; content of rock fragments; and content of organic matter and other features that affect fertility.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments. The ratings are for the whole soil, from the surface to a depth of about 5 feet. It is assumed that soil layers will be mixed when the soil material is excavated and spread.

The ratings are based on the amount of suitable material and on soil properties that affect the ease of excavation and the performance of the material after it is in place. The thickness of the suitable material is a major consideration. The ease of excavation is affected by large stones, depth to a water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the AASHTO classification of the soil) and linear extensibility (shrink-swell potential).

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area. The ratings are based on the soil properties that affect plant growth; the ease of excavating, loading, and spreading the material; and reclamation of the borrow area. Toxic substances, soil reaction, and the properties that are inferred from soil texture, such as available water capacity and fertility, affect plant growth. The ease of excavating, loading, and spreading is affected by rock fragments, slope, depth to a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, depth to a water table, rock fragments, depth to bedrock or a cemented pan, and toxic material.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Ponds and Embankments

Table 21 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the saturated hydraulic conductivity (K_{sat}) of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. Embankments that have zoned construction (core and shell) are not considered. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, K_{sat} of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey.

Soil properties are ascertained 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 particle-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 are shown in tables. They include engineering properties, physical and chemical properties, and pertinent soil and water features.

Engineering Properties

Table 22 gives the engineering classifications and the range of engineering properties for the layers of each soil in the park.

Depth to the upper and lower boundaries of each layer is indicated.

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 15 percent or more, an appropriate modifier is added, for example, “gravelly.”

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-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 particle-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 250 millimeters in diameter and 70 to 250 millimeters 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.

Physical Soil Properties

Table 23 shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the park. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

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 soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (K_{sat}), 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.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at $^1/_3$- or $^1/_{10}$-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability (K_{sat}) refers to the ability of a soil to transmit water or air. The term "permeability," as used in soil surveys, indicates saturated hydraulic conductivity (K_{sat}). The estimates in the table indicate the rate of water movement, in inches per hour, 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 soil layer. The capacity varies, depending on soil properties that affect retention of water. 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.

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 the basis of 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,* 6 to 9 percent; and *very high,* greater than 9 percent.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, 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 by returning crop residue to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion Properties

Table 24 shows estimates of some erosion factors that affect a soil's potential for different uses. These estimates are given for each layer of every soil for K factors and are given as one rating for the entire soil for the T factor, the wind erodibility group, and the wind erodibility index. Values are reported for each soil in the park. Estimates are based on field observations and on test data for these and similar soils.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Soil erosion factors Kw and Kf quantify soil detachment by runoff and raindrop impact. These erosion factors are indexes used to predict the long-term average soil loss from sheet and rill erosion under crop systems and conservation techniques. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) 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 and on soil structure and $K_{sat.}$ Values of

K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

The procedure for determining the Kf factor is outlined in Agriculture Handbook 703, “Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE),” USDA, Agricultural Research Service, 1997.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments. In horizons where total rock fragments are 15 percent or more, by volume, the Kw factor is always less than the Kf factor.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size. Soil horizons that do not have rock fragments are assigned equal Kw and Kf factors.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/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 susceptibility to wind erosion in cultivated areas. 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 described in the “National Soil Survey Handbook.”

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Total Soil Carbon

Table 25 gives estimates of total soil carbon. Soil carbon occurs as organic and inorganic carbon.

Soil organic carbon (SOC) is carbon (C) in soil that originated from a biological source, such as plants, animals, or micro-organisms. SOC is found in both organic and mineral soil layers. The term “soil organic carbon” refers only to the carbon occurring in soil organic matter (SOM). Soil organic carbon makes up about one-half the weight of soil organic matter. The rest of SOM is mostly oxygen, nitrogen, and hydrogen.

Soil inorganic carbon (SIC) is carbon found in soil carbonates, typically as calcium carbonate layers in the soil or as clay-sized fractions throughout the soil. Carbonates in soils are most common in areas where evaporation rates exceed precipitation, as is the case in most desert environments. Typically, the carbonates accumulated from carbonatic dust or from solution during periods of wetter climates. Soil inorganic carbon also occurs in soils that formed in marl in all regions of the country.

The SOC and SIC contents are reported in kilograms per square meter to a depth of 2 meters or to a representative depth of either hard bedrock or a cemented horizon. The SOC and SIC values are on a whole soil basis, corrected for rock fragments.

SOC can be an indicator of overall soil fertility and soil quality that affects ecosystem function. SOM is the main reservoir for most plant nutrients, such as phosphorus and nitrogen. Managing for SOC by managing for SOM increases the content of these elements and improves soil resiliency.

Soil organic matter binds soil particles together and thus increases soil porosity and water infiltration and allows better root penetration and waterflow into the soil. Greater inflow of water reduces the hazard of erosion and the rate of surface water runoff.

Greater SOC levels improve not only soil quality but also the quality of air and water. Soil acts as a filter and improves water quality. Fertile soils that support plant life remove CO_2 from the atmosphere and increase oxygen levels through photosynthesis. Maintaining the level of soil organic carbon reduces C release into the atmosphere and thus can lessen the effects of global warming.

SIC influences the types of plants that will grow. High SIC levels are commonly associated with a higher soil pH, which limits the types of plants that will thrive.

Like SOM, soil carbonates, the source of SIC, also bind soil particles together. They fill voids in the soil and thus can reduce soil porosity. Compacted soil carbonates may restrict root penetration and waterflow into the soil.

Soil Features

Table 26 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness of the restrictive layer, which significantly affects the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (K_{sat}), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes 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 or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete 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 also is expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Water Features

Table 27 gives estimates of various soil 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 a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. Table 27 indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding 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 ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area 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.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

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.

Chemical Soil Properties

Table 28 shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the park. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Cation-exchange capacity is the total amount of extractable 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. Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Soil reaction is a measure of acidity or alkalinity. The pH of each soil 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.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil. Incorporating nitrogen fertilizer into calcareous soils helps to prevent nitrite accumulation and ammonium-N volatilization.

Gypsum is expressed as a percent, by weight, of hydrated calcium sulfates in the fraction of the soil less than 20 millimeters in size. Gypsum is partially soluble in water. Soils that have a high content of gypsum may collapse if the gypsum is removed by percolating water.

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.

Sodium adsorption ratio (SAR) is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. Soils that have SAR values of 13 or more may be characterized by an increased dispersion of organic matter and clay particles, reduced saturated hydraulic conductivity (K_{sat}) and aeration, and a general degradation of soil structure.

Formation and Classification of the Soils

Changes initiated by the explosion of Sunset Crater 960 years ago to the south of Wupatki National Monument (Wupatki NM) are still observed in the soils, vegetation, and fauna. A few centimeters of tephra material covers much of the park (Hooten et al., 2001). Because the park is some distance from the explosive cinder cone of Sunset Crater Volcano National Monument, most of the tephra is ash (less than 2 millimeters in diameter). The tephra cover is more substantial in the south and the west and in topographical lows where ash is sheltered from winds and sheet wash from runoff, especially beneath the faces of escarpments, such as Woodhouse Mesa and Doney Cliffs (fig. 216).

The 900-year-old ash mulch in the park collects and retains a significant quantity of moisture so that plants can grow in environments where they normally could not because of rainfall amounts. For example, juniper and apache plume cover much of Antelope Prairie and Wupatki Basin, areas that receive marginal amounts of needed precipitation. Grasses grow a bit taller than expected for the climate wherever there is cinder mulch. As a result, the soils in the area accumulate more organic matter than anticipated.

Factors of Soil Formation

Individual soils represent multiple processes causing simultaneous geological, chemical, and physical transformations over time. Soil profile development proceeds by five basic soil-forming factors: (1) type of parent material, (2) living organisms, or plant and animal life, (3) climate, both past and present, (4) topography, or physical relief, and (5) time. All soil-forming factors interrelate. Climate affects and determines the kind of organisms that can live in an area. Organisms often increase soil water infiltration, which influences the weathering rate of parent material. Consistency of parent material within an area influences topography. The influences of climate, organisms, parent material, and relief all occur over periods of time. This section discusses each factor separately and examines how each influences soil formation overall.

Parent Material

Geologic Setting

Parent material has a strong influence on the soils in Wupatki NM. Overall change is slow in the desert. Mineral grains weather slowly. Soils tend to develop, erode, and become deposited slowly. Organic matter accumulates slowly. Moisture evaporates quickly. Time has not allowed for significant changes in cinders and ash. The parent materials of soils in the park include sedimentary, igneous, and Quaternary geologic formations. The west end of the park is within the eastern portion of the San Francisco Volcanic Field, an extensively active area with more than 600 volcanoes. The east end of this volcanic field has several cinder cones that have been active in recent geologic history. Three major cinder cones have erupted in the area: SP Crater to the west, Sunset Crater to the south, and Merriam Crater to the southeast. Older lava flows

Figure 216.—Rocks of the Moenkopi Formation frame Doney Mountain and Doney Cliffs. Rocks and soil topographically beneath the cliffs have been protected from weathering, erosion, and transport in relation to rocks and soil on top of the cliffs. Map unit 118 (Shinume channery sandy clay loam, 2 to 30 percent slopes) is in the foreground. Note the concentration of dark cinders and ash in concave slope positions in the distance. These cinders originated from Sunset Crater eruptions. In color contrast, soils that formed from the Moenkopi Formation inherited the red color of the parent material. Doney Mountain erupted 250,000 years previous to the Sunset Crater eruption. Its cinders are concentrated around its base.

dominate the western one-third of the park. The eastern boundary is dominated by the Grand Falls Lava Flow dating back 20,000 years (Hanson, 2008).

East of the volcanic field within the park is Antelope Prairie, a broad flat expanse of the Permian Kaibab Formation that extends to Doney Cliffs. Doney Cliffs and Doney Mountain formed as a result of normal faulting. To the east, and topographically below Doney Cliffs, is the Wupatki Basin. The Wupatki Basin extends to the eastern park boundary, ending at Black Falls Crossing on the Little Colorado River where the Painted Desert begins.

A substantial underground airspace exists which connects to underground fractures in the Kaibab Formation and to the atmosphere through blowholes. Differences in air temperature and pressure drive the movement of air to velocities as high as 56 kilometers per hour (Graham, 2011). Large cracks that open deep within the crust affect drainage. Valley-fill soils on top of fallen fault blocks of the Kaibab Formation have cracks that extend to substantial depths. During monsoonal storms, enormous quantities of water can drain into these cracks and disappear within the earth.

Sedimentary Formations

Two sedimentary formations cover a total of 55 percent of the surface in Wupatki National Monument. Listed from oldest to youngest, they are:

Kaibab Limestone.—This Permian formation has white to light gray or tan, resistant massive beds of limestone and dolomite and calcium carbonate cementation (fig. 217). It also has minor thin layers of shaly siltstone and sandstone, gypsifereous siltstone, fossiliferous chert nodules, and calcite.

Moenkopi Formation.—This Triassic formation has dark red, moderately resistant marginal marine and fluvial beds of sandstone, siltstone, mudstone, and conglomerate as well as gypsum (fig. 218).

The Kaibab Limestone has a fractured system related to faults and dissolution. The Moenkopi Formation rests on top of the Kaibab Limestone wherever it is topographically sheltered from erosion.

Other formations exist in very limited areas. A few remnants of the Shinarump Member of the Chinle Formation exist in the far east portion of the park (fig. 219). A formation beneath the Kaibab Limestone—the Toroweap Formation—is restricted to deep canyon walls in the Doney Cliffs area. Sedimentary deposition ranges from the Permian to Triassic period (265 million years ago to about 240 million years ago). Soils weathered from sedimentary residuum tend to be restricted to shallow depths.

The Kaibab Limestone is associated with Meriwhitica and Peshlaki soils (see Doney Mountain and Doney Cliffs 3D Soil Types). Meriwhitica soils are derived from the residuum and colluvium of Doney Cliffs. Peshlaki soils are derived from mostly unweathered rocks of the Kaibab Limestone with a very shallow covering of tephra. Peshlaki soils occupy the area above Doney Cliffs in very erosive positions on the

Figure 217.—The Kaibab Limestone at Doney Cliffs. This jointed tan-colored formation weathers to boulders and stones. The residuum of this formation forms a coarse-loamy soil and is a carbonate source. The area is in map unit 108 (Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes).

Figure 218.—The Moenkopi Formation at Deadman Wash. This red formation is highly variable in particle size and weathering intensities. Interbeds can be sandstone, shale, siltstone, or mudstone and weather to a channery shallow residuum with intermediate amounts of clay.

relatively flat Antelope Prairie. Much of Antelope Prairie may have been barren rock outcrop before the Sunset Crater explosion.

Chedeski soils are in areas similar to those of Peshlaki soils but differ in that they are derived from Moenkopi Formation residuum (see Antelope Prairie and Citadel 3D Soil Types). Below Doney Cliffs, in the drier moisture zone, the Moenkopi Formation weathered to residuum, from which Moenkopie and Shinume soils formed. Because they originate from different members within the formation, Moenkopie soils have relatively more sand and Shinume soils have more clay (see Black Falls Crossing 3D Soil Types and table 23).

Sandy, Typic Torriorthents are derived from the Shinarump Member of the Chinle Formation and alluvial terrace deposits.

Igneous Rocks

Igneous deposits, apart from ash and cinder veneer deposits, cover 12 percent of Wupatki National Monument. Volcanologists have identified five or six lava flows at the upper elevations of the monument that range in age from 1 million years to 600,000 years (Hanson, 2008). The oldest basalt flow is in the southwest corner of the monument at Woodhouse Mesa. The western half of the park from Lomaki Ruin and Hulls Canyon to the western boundary also consists of extensive older lava flows.

The western half of the park has been reshaped many times from intermittent volcanic activity. Seven or eight events have been identified. The extensive flows from the west park entrance to the Citadel Ruin area—the Black Point and Citadel Flows—date from 865,000 to 870,000 years ago (Hanson, 2008). Citadel Sink is thought to have been produced by acidic water seeping into fractures and dissolving limestone beneath the Citadel Flow. The sinkhole measures approximately 150 meters (500 feet) by 200 meters (650 feet) (Graham, 2011).

Residuum from these lava flows has weathered to clay minerals and been in place long enough to form soils with strongly developed argillic and calcic horizons. Flaco soils in the Antelope Hills area formed in moderately deep residuum of relict lava flows. These soils also have a covering of tephra (See Big Hawk Valley and Antelope Hills 3D Soil Types). Nalakihu soils formed in similar parent material in the drier moisture zone and lack an argillic horizon.

Quaternary Deposits

Quaternary deposits from eolian and alluvial sources of various ages cover 33 percent of Wupatki NM. Deeper soils are derived from alluvial, slope alluvial, and eolian sources as well as from tephra from recent volcanoes.

Alluvium

The Grand Falls Lava Flow is the most recent lava flow (20,000 years old) within Wupatki National Monument (fig. 220). This alkali olivine basalt flow originated from one of the vents near Merriam Crater, flowing 10 kilometers to the Little Colorado River, where it filled the canyon and created Grand Falls. The flow continued downstream along the bed of the Little Colorado River 25 kilometers from Grand Falls to Wupatki NM, near Black Falls Crossing (Hanson, 2009). Much of the flow is now

Figure 219.—The Chinle Formation in the vicinity of Black Falls Crossing. The Shinarump Member of this formation is commonly covered with chert lag gravel and weathers to moderately deep and deep sandy soils, such as those in map unit 117 (Sandy Typic Torriorthents, 1 to 15 percent slopes).

Figure 220.—The Grand Falls Lava Flow near Black Falls Crossing, in map unit 119 (Trachute-Lava flows complex, very rarely flooded, 0 to 5 percent slopes). To reach this area, the lava flowed northeast from the Merriam Crater area to the Little Colorado River. The river channel filled, which resulted in the creation of the Grand Falls. The lava continued down the river bed and stopped near Black Falls Crossing. Sand from the Little Colorado River was deposited on top of the flow during storms.

partially covered by sands deposited by the Little Colorado River during very rare flooding events. The alluvial sand on top of the Grand Falls Lava Flow is mapped as Trachute soils. The Grand Falls Lava Flow itself is relatively unweathered indurated basalt (see Black Falls Crossing 3D Soil Types).

Other young terrace deposits in Wupatki Basin are Doney Mountain Wash and Deadman Wash. The canyon area at Deadman Wash is mapped as Rock outcrop-Torriorthents-Heiser association, 3 to 40 percent slopes (map unit 116). The area further down the wash where the canyon gives way to flood plains is mapped as Ives-Riverwash complex, rarely flooded, 1 to 5 percent slopes (map unit 107) (see Black Falls Crossing 3D Soil Types).

Terrace deposits on Antelope Prairie are mapped as Flaco soils, which have strong argillic and calcic horizons, and as Pocum soils, which have petrocalcic horizons (see Antelope Prairie and Citadel 3D Soil Types).

Pleistocene gravel of limestone, sandstone, chert, and basalt form terrace benches in the Wupatki Basin (fig. 221). The oldest terrace deposits correspond to flood-plain deposits predating faulting at Doney Cliffs. Older deposits may be partially cemented with calcite and gypsum (Billingsley et al., 2007). The oldest terrace deposits in the Wupatki Basin are cemented with silica from the glass found in igneous rock fragments. The once continuous deposits capped the Triassic Moenkopi Formation (Graham, 2011). The paleoterrace in some places in Wupatki Basin forms a duripan that is resistant to erosion. Areas at the edges of the paleoterrace that gather windblown deposits of ash are mapped as Miburn soils in map unit 110 (Miburn-

Cambidic Haplodurids complex, 1 to 8 percent slopes) (see Wupatki Basin and Woodhouse Mesa 3D Soil Types).

Tephra Deposits

Another source of volcanic parent material is the tephra that covers much of the park. Volcanic ash and cinders are products of rock shattering from episodes of violent gas release. The recent explosion of Sunset Crater left various sizes of fresh black tephra on the surface throughout much of the park. The tephra has geochemical attributes similar to those of the tephra at Sunset Crater. Geochemical analyses determine major and trace elements that are present in samples. These character proportions of elements are then used to distinguish two tephra deposits. Thus, each volcanic event carries a chemical fingerprint. These fingerprints have been previously identified at Wupatki NM (Hooten et al., 2001). Sunset Crater tephra is geochemically distinct from a second source—the Doney Mountain tephra that is oxidized to a red color (fig. 222). The Doney Mountain tephra is primarily cinder sized. However, it has only been found in the proximity of Doney Mountain. Previous to the Sunset Crater explosion, Antelope Prairie was mostly devoid of ash (Hooten et al., 2001). Doney Mountain formed as a result of an eruption of cinders and lava along the trace of Doney Fault within the park. There were numerous eruptions along the fault between 250,000 to 500,000 years ago. Doney Mountain formed from very deep tephra deposits of red iron-oxide-coated cinders and some carbonates. Soils that formed from the Doney Mountain tephra are in map unit 121 (Vitrandic Torriorthents, 10 to 63 percent slopes) on Doney Mountain itself and in map unit 101 (Bighawk family gravelly sand, 2 to 11 percent slopes) at the base of the mountain.

Figure 221.—Pleistocene or earlier river deposits in the Wupatki Basin area, in map unit 110 (Miburn-Cambidic Haplodurids complex, 1 to 8 percent slopes). The boulders and stones deposited by the ancient river are a mixture of basalt and sedimentary limestone and chert.

Figure 222.—Igneous rock at Doney Mountain, in map unit 121 (Vitrandic Torriorthents, 10 to 63 percent slopes). Parts of the cinder mountain may be covered with welded tuff. Albedo, soil temperature, and runoff may inhibit vegetative growth.

In Big Hawk Valley in the Antelope Hills area, there is a third tephra parent material. Tan-colored cinders are buried just beneath the Sunset Crater tephra (fig. 223). The tan tephra appears to have moved as alluvium. The tephra source was probably west of the monument since uphill aspects of the geomorphic landform are in that direction. These cinders are thoroughly coated in carbonate. Such a heavy coating of carbonates limits the number of beneficial pore spaces in the fragments. Carbonates contribute to soil inorganic carbon (see table 25). However, when the cinders are shattered, the pore spaces are found to be preserved within the “nutshell” of the cinder.

Eolian and Dune Deposits

The recent explosion of Sunset Crater in 1064 had the greatest impact on parent material at Wupatki NM, an impact which has continued episodically for 50 to 200 years (Hooten et al., 2001) (fig. 224). Cinders and ash cover a majority of the park soils (fig. 225). Surficial deposits of tephra have influenced many soil properties, which in turn have influenced the flora and fauna of the area. Water-holding capacity, water infiltration, moisture retention, temperature, surface erosion, particle-size distribution, and color are just some of the soil properties that have been changed by the influx of tephra parent material.

Eolian cinder and ash dune deposits in Wupatki Basin are derived from material separated and carried by southwesterly winds. The coarse ash fraction (sand-sized particles of tephra) is the specific size that has separated from the cinder source material and accumulated near the Visitor Center (fig. 226). Deep and very deep accumulations extend from the area of the Visitor Center to approximately 1.5 kilometers southeast beneath Woodhouse Mesa. The deposits provide some unusual

Figure 223.—Tan-colored cinders at Bighawk Valley, once shattered, reveal the porous inner rock structure of tephra. The carbonate coating resembles a nutshell around the tephra. The age and the source of this tephra are unknown.

Figure 224.—Landscape of recent ash dune deposits from the Sunset Crater eruption below Woodhouse Mesa, south of the Visitor Center. Vegetation and moisture make these sands less vulnerable to erosion. The area is in map unit 109 (Miburn coarse sand, 1 to 10 percent slopes).

Figure 225.—Doney Cliffs are the result of normal block faulting from tectonic uplifting. The cliffs separate the Antelope Prairie in the western upper half of the park from the Wupatki Basin in the eastern half. The dark tephra cover appears like shadows across the landscape. Several map units can be seen from this viewpoint on Doney Mountain. Map unit 115 (Peshlaki-Rock outcrop complex, 1 to 11 percent slopes) is on the Antelope Prairie above and to the west of Doney Cliffs. Much of this part of Antelope Prairie is barren rock without the tephra cover produced by the Sunset Crater explosion. Much soil is lost quickly due to the erosive landscape position. Map unit 108 (Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes) consists of unstable soil that formed upon the cliffs. Beneath the cliffs in the ash cover is map unit 101 (Bighawk family gravelly sand, 2 to 11 percent slopes). The tephra of this map unit originated from Sunset Crater and covered a tephra layer originating from Doney Mountain. Beyond map unit 101, the exposed red rocks are in the vicinity of map unit 118 (Shinume channery sandy clay loam, 2 to 30 percent slopes). The cindery area on Doney Mountain (in the foreground) is map unit 121 (Vitrandic Torriorthents, 10 to 63 percent slopes).

soil and water properties for vegetation. Rainfall penetrates quickly into the soil matrix and fills pores within the fragments, which may hold water for long periods without evaporation. Beneath the present ash deposits are older, buried climbing sand dune deposits of quartz sands, which were also carried by southwesterly winds. Miburn soils represent soils that have more than 18 centimeters of ash originating from Sunset Crater. Heiser soils represent soils that have more than 100 centimeters of ash originating from Sunset Crater (see Wupatki Basin and Woodhouse Mesa 3D Soil Types).

Particle size of grains influences moisture retention and vegetative productivity. Soils consisting of gravel and sand cannot retain moisture for even short periods while soils with silt and clay particle sizes retain ample available moisture for a greater variety of plants. Quartz grains of common sand sediments do not have capillary spaces and lack surface cohesion to water, thus allowing water to infiltrate rapidly through the soil profile unimpeded. Much of the Colorado Plateau has soils of quartz sands that do not retain moisture in the upper half of the profile. However, most of the soils in Wupatki NM do not follow this pattern.

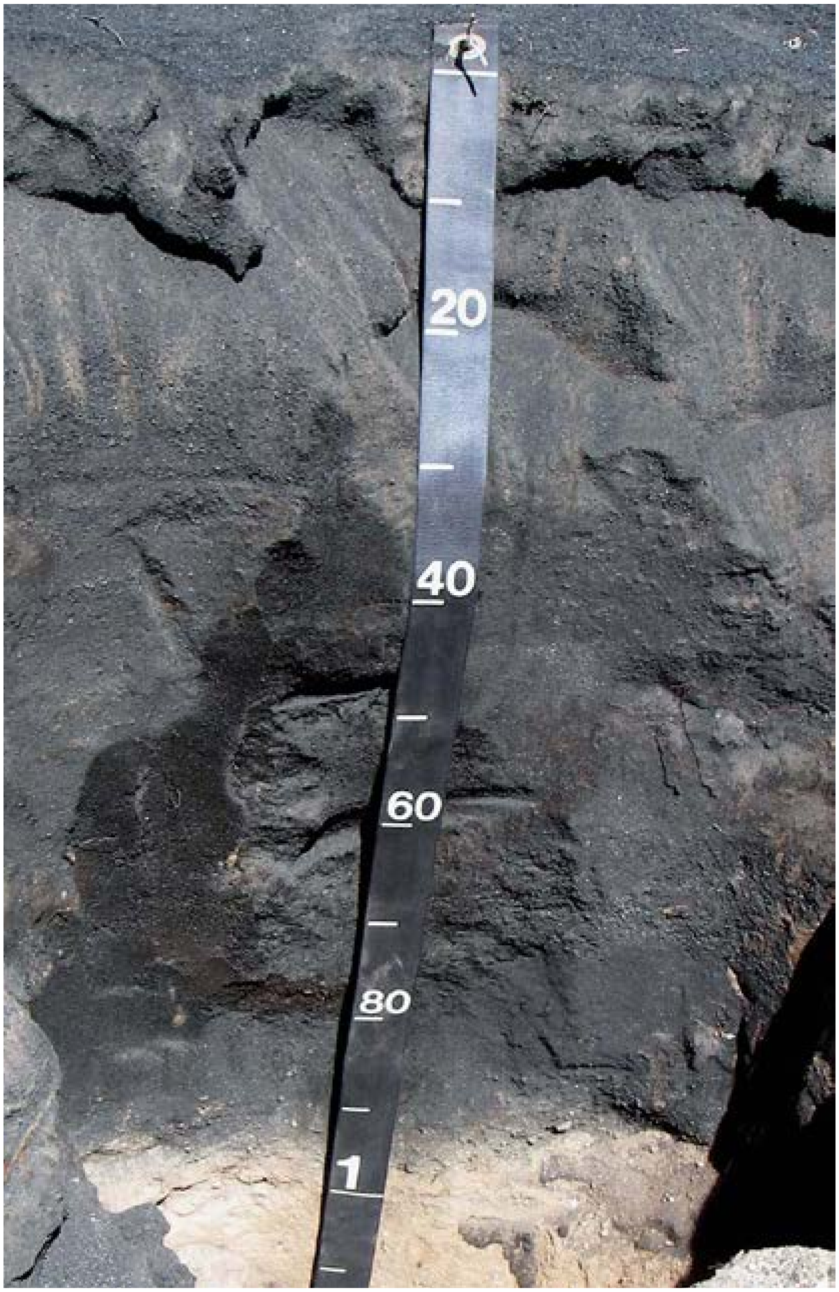


Figure 226.—Thick deposits blanket an area south of the Visitor Center, in map unit 109 (Miburn coarse sand, 1 to 10 percent slopes). Recent ash deposits originated from Sunset Crater approximately 850 to 900 years ago. After the initial ash fallout, these ash dune deposits accumulated from further wind deposition that covered older quartz dune sand deposits beneath the foot of Woodhouse Mesa.

Soils in Wupatki NM frequently have a surface of tephra consisting of pyroclastic grains. Pyroclastic grains hold moisture far more effectively than sedimentary grains because pyroclastic grains have capillary pore spaces that do not interconnect. The pyroclastic size term equivalent to gravel is cinders, that equivalent to sand grains is coarse ash, and that equivalent to silt grains is fine ash. All of these pyroclastic grains retain extra moisture within capillary pores. Soils of fine ash have exceptional moisture retention. Available water capacity is summarized in table 23.

Today, almost no fine ash deposits are found in Wupatki NM. However, fine ash may have been extensive in the past. Geological research indicates that the entire park area was covered with a minimum of 5 to 10 centimeters (2 to 4 inches) of ash during the eruption of Sunset Crater. The fine ash would have been susceptible to wind erosion (Hooten et al., 2001).

Harold S. Colton proposed that use of lithic mulch aided the Sinagua people in farming lands that were not arable prior to the Sunset Crater eruptions (Colton, 1932 and 1946; Downum and Sullivan, 1990). The beneficial nature of surficial ash and cinder layers, which act as a water-retaining and temperature-moderating mulch, can be significant for a number of reasons (Cook et al., 1981; Shoji et al., 1993; Lightfoot, 1996; Ort et al., 2008a and 2008b):

1. Ash lacks the continuous pores for capillary and saturated flow that reduce excessive infiltration and increase water retention.
2. The greater reflectance of ash-covered surfaces reduces peak soil temperatures and water evaporation.
3. Lithic mulches reduce turbulent air flow over surfaces and thus reduce temperature extremes, wind erosion, and soil desiccation.
4. Ash and cinder fragments can lower soil pH from moderately alkaline to neutral, depending on age and environmental condition. Phosphorous is more available for plants in soils that are neutral than in those that are alkaline.
5. Pore spaces accumulate organic matter, which increases the content of soil nitrogen.
6. Fresh cinders and ash inhibit salinization.
7. Allophane can form from volcanic ash to a degree that improves water retention. Allophane is an amorphous mineraloid that further alters to halloysite. It is common within the Andisols order, soils in which phosphorous is easily fixed.

By 1250 A.D., the Wupatki settlements were abandoned. Tree-ring and archeological evidence suggest that an increasingly dry, semi-arid climate reduced water availability for crops. One outcome of volcanic soil desiccation is that pore spaces that could retain moisture become filled with carbonates or evaporites, thus reducing the amount of water a soil formed from tephra can retain. Another outcome is that soil particles may become sealed together into a groundmass. A third and final outcome is that noncohesive ash may be lost to wind erosion (Dubroeucq et al., 1998). The most vulnerable soil particles to wind erosion are fine ash.

The tephra covering at Wupatki NM continues to have an enormous impact on the park soils. One might expect soils that have similar moisture, parent material, and landforms to have formed similarly. However, differences between tephra-covered sedimentary soils and sedimentary soils without tephra covering are readily apparent. For example, two landforms, one at Doney Cliffs in Wupatki National Monument and one at Eminence Break on the Navajo Reservation east of the community of Cedar Ridge, have the same parent material, same topography, and same precipitation. Eminence Break is 80 miles north-northwest of Doney Cliffs. It is analogous to Doney Cliffs because both are fault blocks that are uplifted approximately 200 feet in relation to the adjoining block by normal faulting. The adjoining source material at both Eminence Break and Doney Cliffs is the Permian Kaibab Limestone. Climate data indicate similar precipitation totals at each location. The single difference is that Eminence Break does not have the tephra cover found at Doney Cliffs. Soils at Doney Cliffs have enhanced organic accumulation from previous years of vegetative growth, whereas soils at Eminence Break generally lack organic carbon (see table 25). Soils at Doney Cliffs have a permanently enhanced soil potential. Vegetation at Doney Cliffs is clearly more productive than that at Eminence Break. This example shows that increased amounts of organic material and increased soil water retention have resulted in visible differences in vegetation and animal habitation.

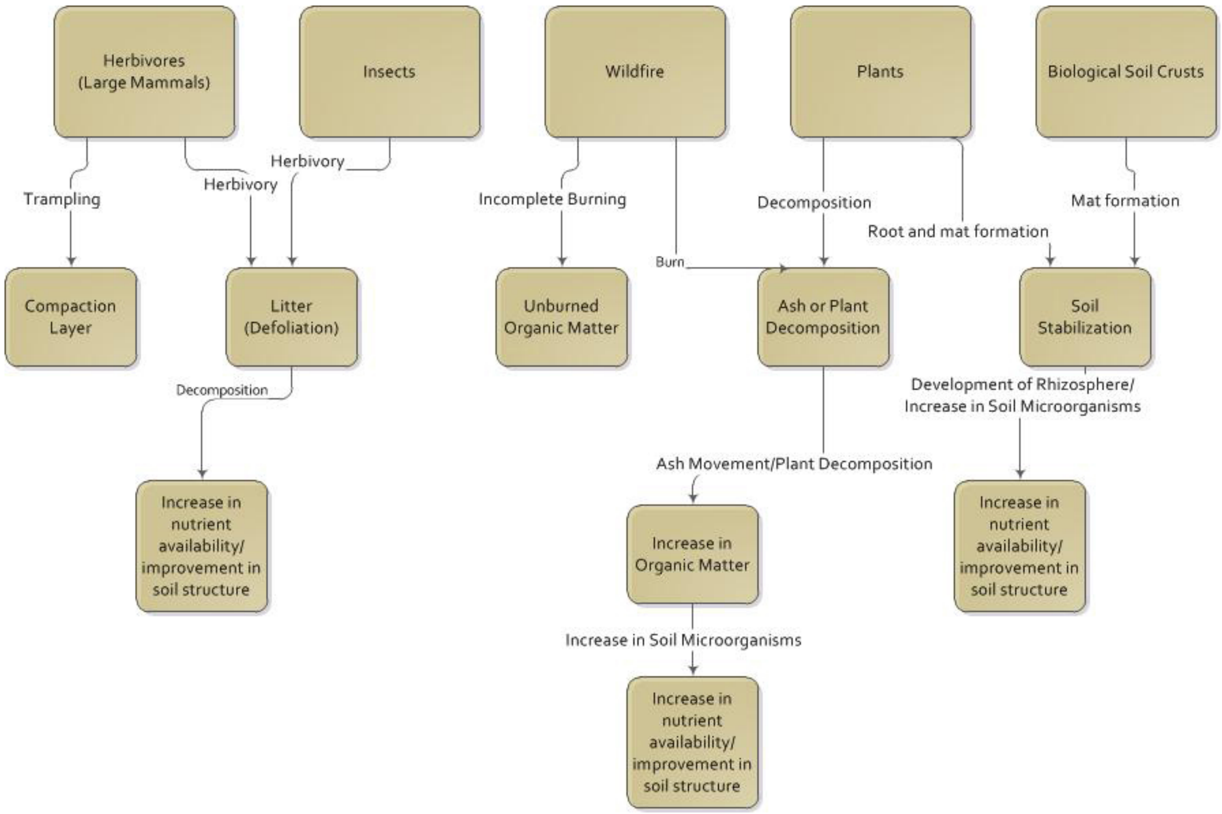


Figure 227.—A flow chart summarizing interrelationships of biotic processes in soil-forming factors.

Table 8 lists the dominant parent material type for each major soil in the park map units.

Organisms

This section was prepared by Jennifer M. Puttere, ecological site inventory specialist, Natural Resources Conservation Service.

Plants, animals, and other microbial life do much to loosen, distribute, and sort soil particles (fig. 227). Plants distribute nutrients, stabilize soil particle surfaces, and increase organic matter upon decay. They also intercept precipitation. This interception stops the meteoric impact to soil surfaces, thus reducing soil erosion. In addition, it allows a more gentle infiltration of fine sediments, which then become entrapped in the soil matrix. Plant roots increase soil porosity, which leads to better infiltration, moisture retention, and drainage. Roots help to cycle nutrients through the soil profile.

Organic matter is enhanced throughout much of Wupatki NM and the greater area because it is entrapped within pore spaces of fragments. Once organic matter is entrapped and accumulates, many soil properties are enhanced and more plant life can be sustained. As a result, soil is enriched with organic matter and a cycle of positive feedback is created.

Biotic factors include organisms living both on the soil surface (such as plants and animals) and under the soil surface (such as nematodes, springtails, soil bacteria, and soil fungus) (fig. 228). Many different interrelated events occur to develop and alter the soil surface. Geologic events, such as volcanic eruptions, spread earth materials over the landscape. Large herbivores walk on the surface, compacting the soil, and

Figure 228.—A rattlesnake takes cover within twigs and leaves beneath a juniper on the Antelope Prairie.

selectively browse plants. Insects such as grasshoppers defoliate and create litter; plants grow roots and anchor the soil; wildfire creates nutrient-rich ash; and soil microbes thrive where roots have penetrated the soil (rhizosphere).

Deposition of Ash and Cinders and Its Effects on Migration and Soil Fertility

In arid and semi-arid lands, tephra deposits from scoria cone eruptions may serve as soil mulches, decreasing runoff and evaporation, increasing infiltration, and regulating soil temperature. This can provide new areas for agriculture. During the eruption of Sunset Crater, Wupatki NM was covered with 1 to 10 centimeters of tephra. Thinner cinder deposits, generally 3 to 8 centimeters thick, can help conserve soil moisture, regulate soil temperature, and increase the amount of available soil phosphorus. Because of a climate with increased precipitation, the loss of arable land at the higher elevations due to thick (20 to 30 centimers) tephra deposits, and the gain of newly farmable land at the lower elevations, Wupatki NM became an area of increased migration (Ort et al., 2008a and 2008b). Because mulching from ash and cinders reduced the effects of seasonal variation in precipitation, people were able to grow maize at low elevations where precipitation was minimal (Ort et al., 2008a and 2008b; Sullivan and Downum, 1991).

Volcanic soils formed from ash deposits of scoria cones, such as from the San Francisco Volcanic Field of northern Arizona. These soils tend to have a high cation-exchange capacity (see table 28), high base saturation, and a good water-holding capacity. However, in semi-arid environments, such as in northern Arizona, these same soils may be low in important soil nutrients, such as nitrogen and phosphorus (Ort et al., 2008a and 2008b).

Other Biotic Factors

Large mammals can reduce nutrient cycling through uprooting and trampling plants. They also can contribute to the compaction of soils, which slows the cycling processes (Belovsky and Slade, 2000). Large herbivorous mammals can affect the mineralization rate by selectively browsing more palatable plants and leaving less palatable and less decomposable plants (McNaughton et al., 1997) (fig. 229). Insects can have similar effects on soil nutrients but not cause compaction. They create litter by choosing to feed on plants that are more easily decomposed (Belovsky and Slade, 2000).

Vascular plants stabilize the soil surface, distribute nutrients, and contribute organic matter to the soil. Plants also influence soil properties, such as soil structure. They can promote soil aggregation in various ways, including root penetration, modification of the soil water regime, creating networks of roots in the soil profile, increasing microbial activity in the rhizosphere, and increasing soil carbon input through roots and litter (Angers and Caron, 1998). Soil microbial communities are the primary drivers of nutrient cycling in the rhizosphere (Williams et al., 2012). Microbial activity directly influences plant productivity and diversity by influencing plant growth and development, plant competition, and nutrient and water intake (Kennedy and Stubbs, 2006).

Biological soil crusts are defined by the relationship between differing proportions of soil particles, cyanobacteria, algae, microfungi, lichens, and bryophytes. These organisms are also known as cryptobiotic, cryptogamic, and microbiotic soil crusts (Rosentreter et al., 2007). Biological soil crusts reduce soil erosion, contribute organic

Figure 229.—Antelope at home in Wupatki Basin. The soil in the foreground is organically enriched and has greater moisture retention compared to soils outside the park in the background. The area is in map unit 110 (Miburn-Cambidic Haplodurids complex, 1 to 8 percent slopes).

Figure 230.—A forest fire burns in the San Francisco Peaks, as seen from the northern boundary of Wupatki National Monument. Wildfire is a natural event in the arid climate of northern Arizona.

carbon, fix nitrogen, and either promote the growth of vascular plant seedlings or adversely affect them (Bhatnagar and Bhatnagar, 2005). One of the dominant sources of nitrogen in desert ecosystems is cyanobacteria and cyanolichens. In regions where rainfall is low, the specialized mechanisms which allow these organisms to fix nitrogen and make it available for plant use are crucial (Belnap 2002).

Wildfire affects the cycling of soil and plant nutrients by converting all or part of organic matter and detritus into organic ash and other combustion products (Boerner, 1982) (fig. 230). Some nutrients may be lost to the atmosphere or remain incompletely burned (Boerner, 1982). Frequent fires on the same site can damage soil fertility and alter nutrient cycling (Williams et al., 2012).

Climate

In Wupatki NM, summers are hot and have a monsoonal rain pattern, which starts in July and ends in late September (figs. 231 and 232). Daily highs in July average 95 degrees F. Rainfall peaks in August with an average of 1.5 inches. Fall is a time of transition between monsoonal patterns to more sunny days and colder nights. Winters are cold with occasional accumulations of light snow, which rarely become deep. Minimum temperatures occur in December (average of 25 degrees F). Snowfall peaks in December with an average of 1.6 inches. Daily highs in January average 48 degrees F. Cold winds are occasional. Spring can bring moisture as well as moderately warmer, stronger winds. In June, the climate becomes substantially warmer and drier. Total annual precipitation is 8.17 inches. The climate of the park tends to be consistent with the high diurnal variations of the Colorado Plateau. Weather conditions may change rapidly at any time of the year. See the “Climate” section in the introduction and tables 1, 2, and 3 for more information.

Climate contributes to soil formation in several ways. It influences soil moisture content and soil temperature, which determine the kind and number of soil organisms. Infiltration of moisture after rainfall affects soluble and insoluble transport within and outside of the soil profile. Soil horizon development depends on the movement of water within the profile over time.

Archeological evidence of changing climatic conditions has been found. Reduced precipitation towards the end of the occupation of Wupatki dwellings may have reduced agricultural potential (Smiley, 1958; Pilles, 1979). In addition, the climate change would further degrade both the quality and availability of lithic mulch. As desert climates become increasingly arid, tephra soils become increasingly vulnerable to loss of fine ash from wind erosion and water retention is decreased in the remaining coarse ash and cinders.

Substantial portions of the fine ash may have been eroded by wind. Other portions may have become cemented into groundmass. In the Columbia River Basin east of Mount St. Helens, dry ash behaves physically like unstabilized sand and forms embryonic dunes and foredunes around plants and obstructions. Fine ash forms a nonerodible layer when slightly wetted but can be highly erosive and travel long distances in the air when dry (Cook et al., 1981). Wupatki NM and the rest of the Colorado River basin is the source area for accumulations of eolian materials in Southwest Colorado. Reddish soils form in the eolian deposits located on relatively

Figure 231.—Funnel cloud and rain over an area of map unit 104 (Flaco-Lava flow complex, 1 to 18 percent slopes). Plants protect soil surfaces from the meteoric impact of water droplets and thus reduce soil erosion.

Figure 232.—Monsoon storm clouds form over the east end of Wupatki Basin. The oxidized, red-pigmented soil originates from intermediate Quaternary terrace gravel deposits (background) near the confluence of the Little Colorado River and Deadman Wash (right) and from Quaternary alluvial deposits (foreground). The alluvial deposits are in map unit 107 (Ives-Riverwash complex).

stable landforms throughout most of the Colorado Plateau geologic province of southwestern Colorado (Price et al., 1988). Fine ash from Sunset Crater may have fallen in Wupatki at one time but, if so, has since blown far from the park to the northeast.

Topography

Topography, or physical relief, is characterized by the length, shape, aspect, shape complexity, and degree of surface slope. It influences soil formation by affecting moisture distribution and runoff. The runoff and amount of water infiltration depend in part on slope. Soils on south aspects receive more direct sunlight and are drier and hotter than similar soils on north aspects. These conditions influence soil formation by affecting sunlight intensity, soil moisture, and temperature, all of which determine the kind of vegetation, the susceptibility of soil to erosion, and the cycles of freezing and thawing. Slope patterns also determine the distribution of soil water by runoff and drainage. Topography is determined by landforms and landscapes. Table 8 lists the slope, landform, and landscape of each major soil in each map unit in Wupatki NM.

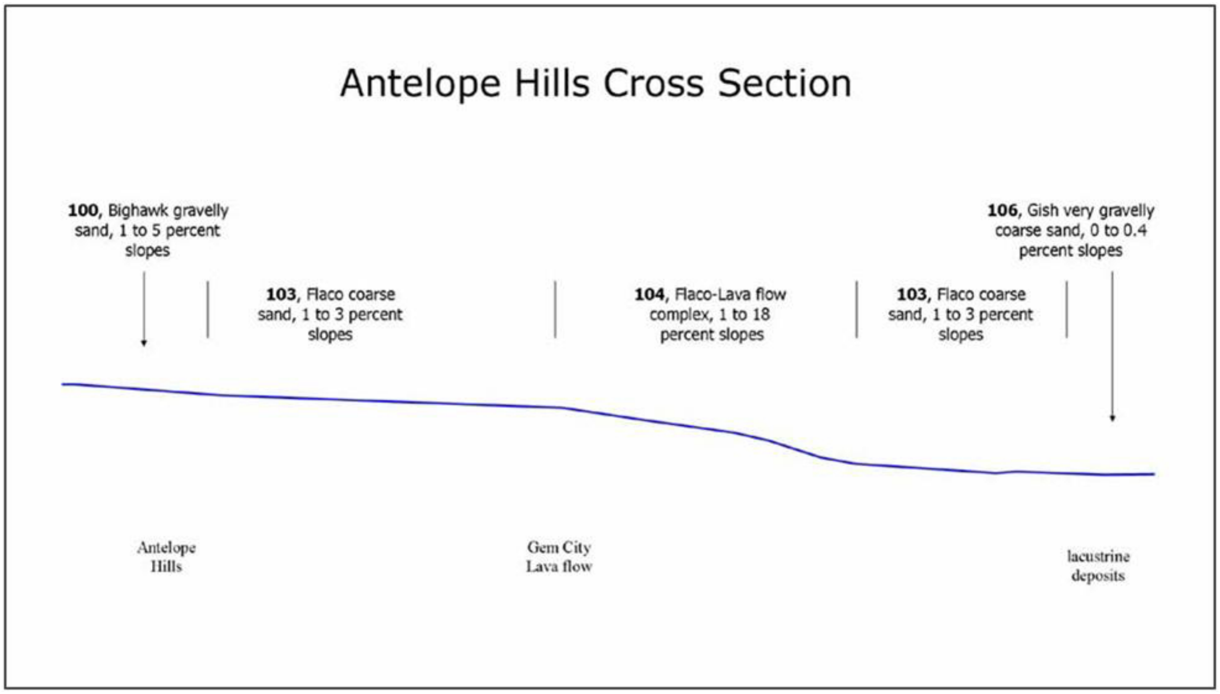
Topography influences soil depth because it controls erosional and depositional patterns. Soil material moves downslope through combinations of forces, most frequently gravity, precipitation, and wind. In the Colorado Plateau, topography and surface shape are commonly controlled by rock structure and tectonic forces. In Wupatki NM, faulting causes local vertical movement of blocks of sedimentary rock. Residuum moves with the moving blocks, increasing the potential for erosion until the soil is moved to the falling block. This is the process of valley fill deposits, such as those of Tsosie soils located south of the Citadel. In similar landscape positions that do not have internal or external water drainage, material accumulates into lacustrine deposits, such as those of Gish soils.

In Wupatki NM, topography is influenced by differential resistance to erosion due to the variable surface strength of various earth cover. Paleoterrace deposits may become harder than the surrounding sedimentary rock and thus favor the erosion of soft rocks over more ancient alluvium. Resistant ancient alluvial beds erode slowly in relation to the surrounding Moenkopi Formation and form the low-lying hills that cap hilltops in Wupatki Basin, where Cambidic Haplodurids are mapped. There is also visible evidence of river beds capping the cuestas west of Black Falls Crossing and covering parts of the sandy Shinarump Member of the Chinle Formation (fig. 233).

Topography influences the thickness of deposits of coarse ash. Windblown deposits commonly occur on the northeast side of canyon rims and cliff faces in Wupatki Basin. Miburn soils formed where ash deposits were thicker than 18 centimeters, while Heiser soils formed where ash deposits were thicker than 100 centimeters.

Figures 234 through 244 show cross sections and their related curvature maps to illustrate topography at selected locations.

Figure 233.—Lag gravel on the cuestas west of Black Falls Crossing may be from the sedimentary beds of the Shinarump Member of the Chinle Formation or from weathered paleoterrace deposits capping this member. This area is in map unit 117 (Sandy, Typic Torriorthents, 1 to 15 percent slopes).



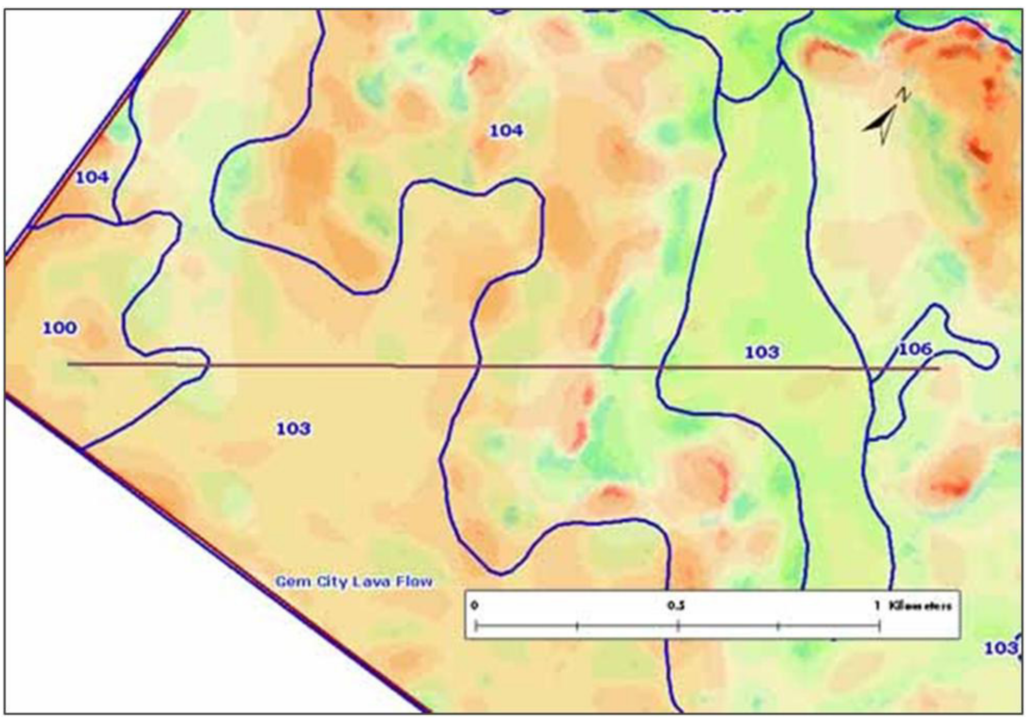


Figure 234.—Cross section and map of Antelope Hills covering a volcanic area at the west end of the park. The cross section crosses the Gem City Lava Flow near the Sinagua Trading Post. The lava flow spreads horizontally and weathers to an even surface. Carbonate silt and ash may contribute to infilling and leveling of the deposit. Map unit 103 (Flaco extremely gravelly coarse sand, 1 to 3 percent slopes) is in nearly flat areas that have been filled in, and map unit 104 (Flaco-Lava flows complex, 1 to 18 percent slopes) is on the gently sloping lava plains with basalt rocks. Map unit 106 (Gish very gravelly coarse sand, 0 to 0.4 percent slopes) is in an area of lacustrine deposits. Map colors relate to curvature. Green colors represent concave points, and brown represents convex points. The white area is outside the park.

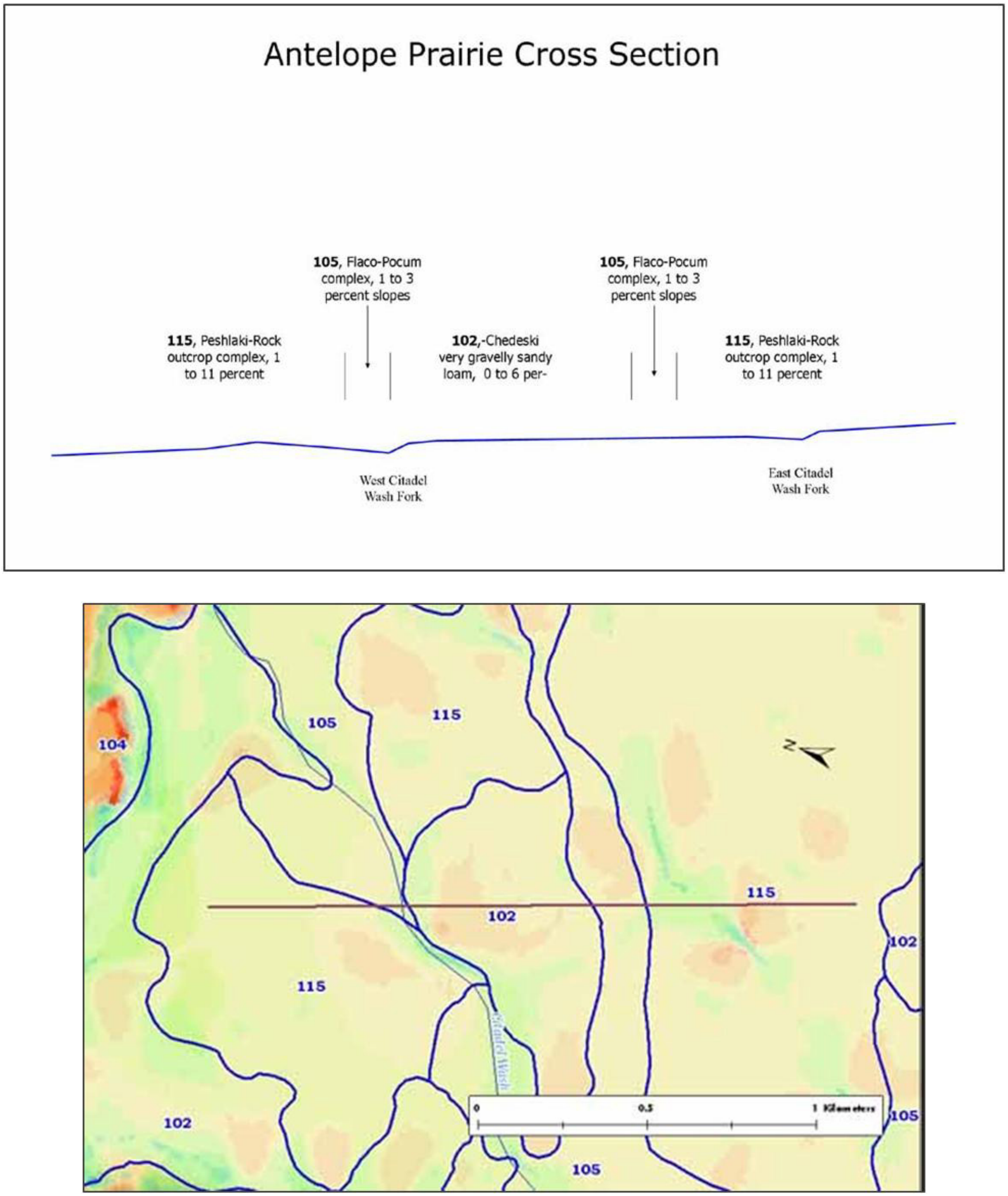


Figure 235.—Cross section and map of Antelope Prairie. Antelope Prairie is the uplifted fault block of the Kaibab Limestone above and west of Doney Cliffs. The soil is a thin tephra covering over weathered sedimentary rock. Because this area is nearly flat, the relationship between topography and map units is slight. Topography in this area is controlled by bedrock weathering. There are a few remnants of a terrace making up map unit 105 (Flaco-Pocum complex, 1 to 3 percent slopes). Map unit 102 (Chedeski very gravelly sandy loam, 0 to 6 percent slopes) is a tephra-covered residuum from the Moenkopi Formation. Map unit 115 (Peshlaki-Rock outcrop complex, 1 to 11 percent slopes) is tephra-covered residuum of the Kaibab Limestone. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points.

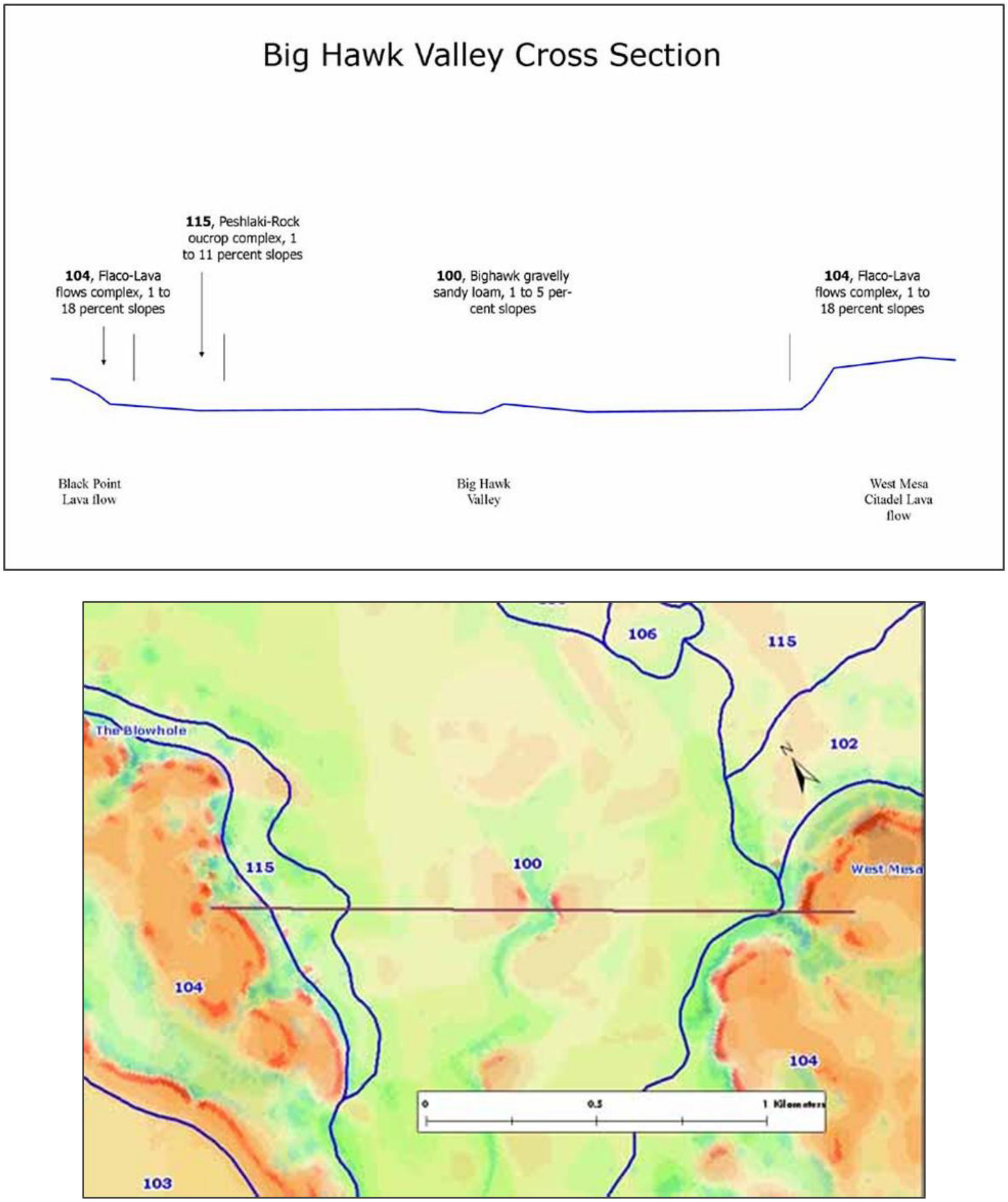
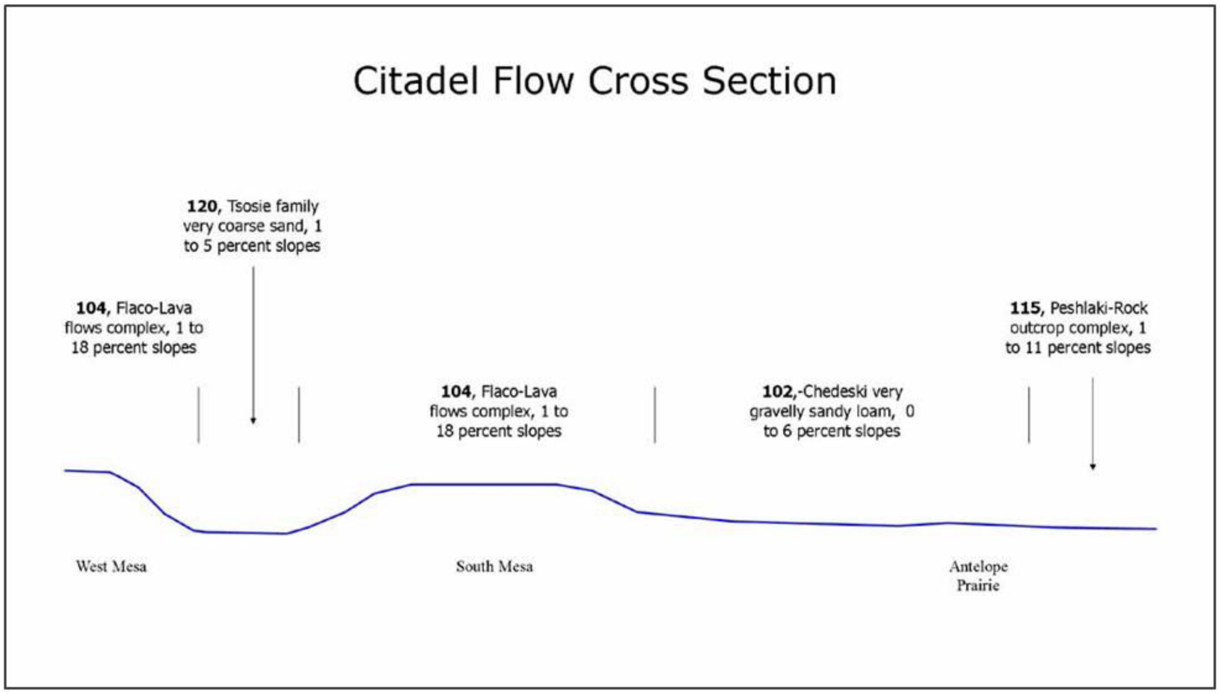


Figure 236.—Cross section and map of Big Hawk Valley. Big Hawk Valley is an older tephra deposit that may have been moved in part by alluvial processes as well as by forces of volcanic eruptions. Fine particles may have been added by wind. Surrounding lava flows are topographic highs. The Bighawk soil (in map unit 100) is a fan deposit of carbonate-coated tephra. Map unit 104 (Flaco-Lava flows complex, 1 to 18 percent slopes) occurs where old lava flows formed valley side slopes. The soils of map unit 115 (Peshlaki-Rock outcrop complex, 1 to 11 percent slopes) formed in residuum of the Kaibab Limestone. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points.



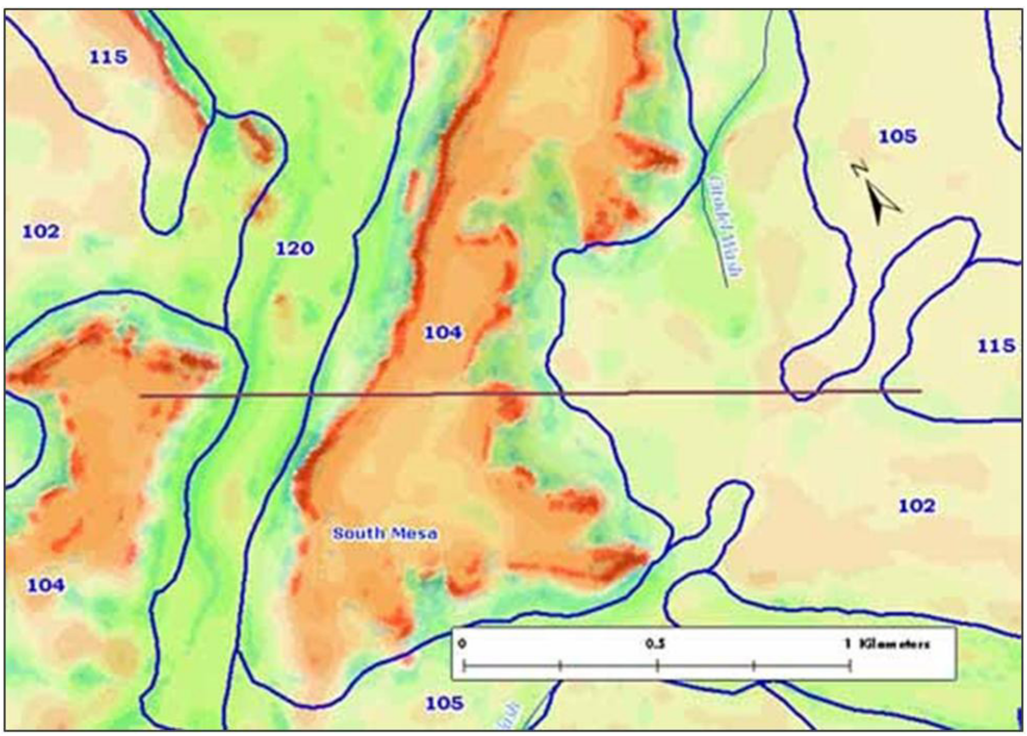


Figure 237.—Cross section and map of the Citadel Flow area south of Citadel Ruin. The cross section covers topography that developed from a succession of events, including lava flows, faulting, and valley fill depositing. Two parts of the Citadel Flow (West Mesa and South Mesa) are topographic highs. They make up map unit 104 (Flaco-Lava flows complex, 1 to 18 percent slopes). The soils in map unit 120 (Tsosie very gravelly coarse sand, 1 to 5 percent slopes) formed in a tephra-covered valley fill deposit over a block that has fallen due to extensional stress to the bedrock. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points.

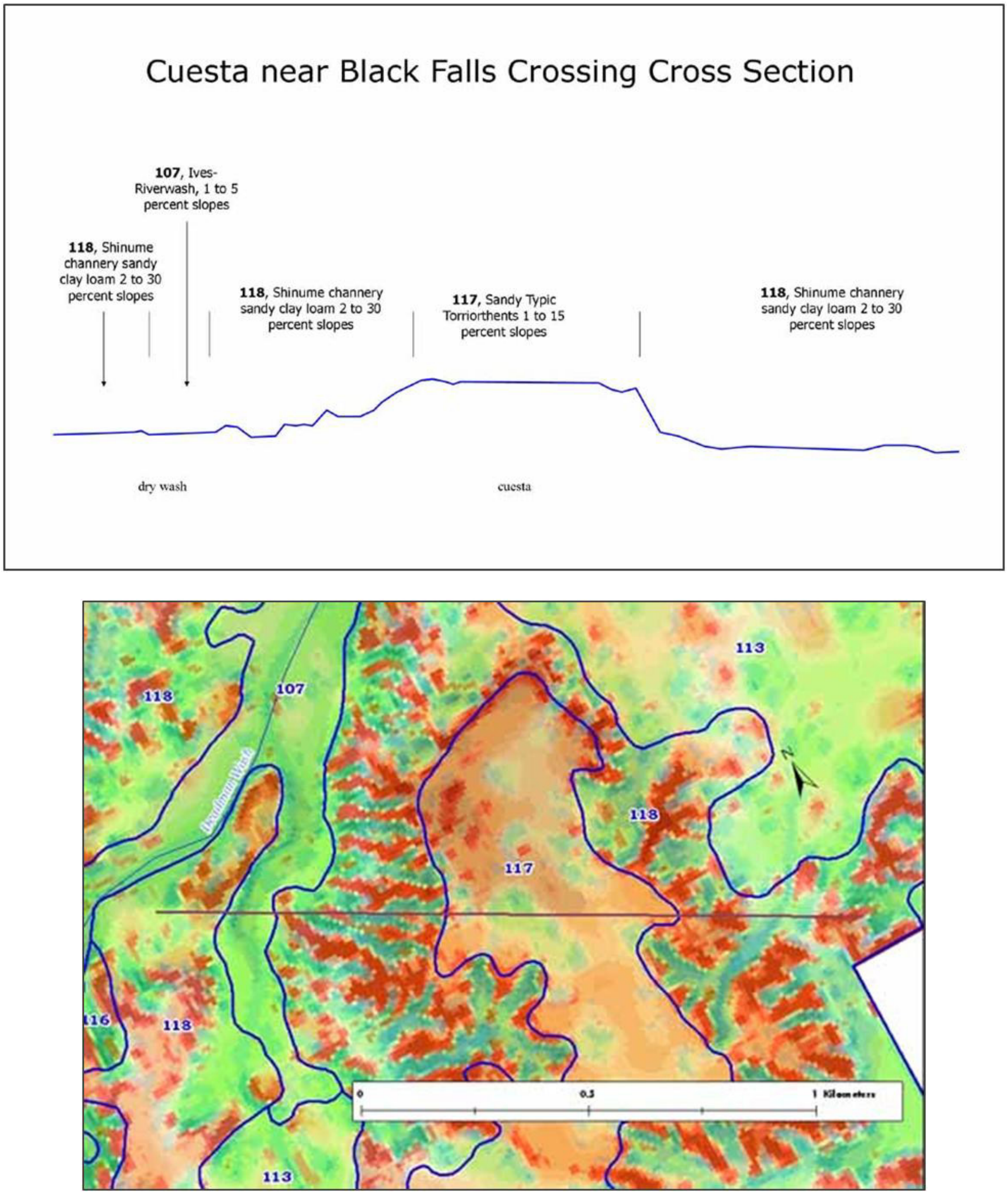


Figure 238.—Cross section and map of a cuesta west of Black Falls Crossing. The cuestas are isolated remnants of the Shinarump Member of the Chinle Formation that make up the major component of map unit 117 (Sandy, Typic Torriorthents, 1 to 15 percent slopes). There are also visible terrace deposits on top of the cuestas in some places. The soil is a sandy residuum with many deposits of round river gravel that have become lag gravel. Alluvial deposits also occur on the cuestas in some places. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points.

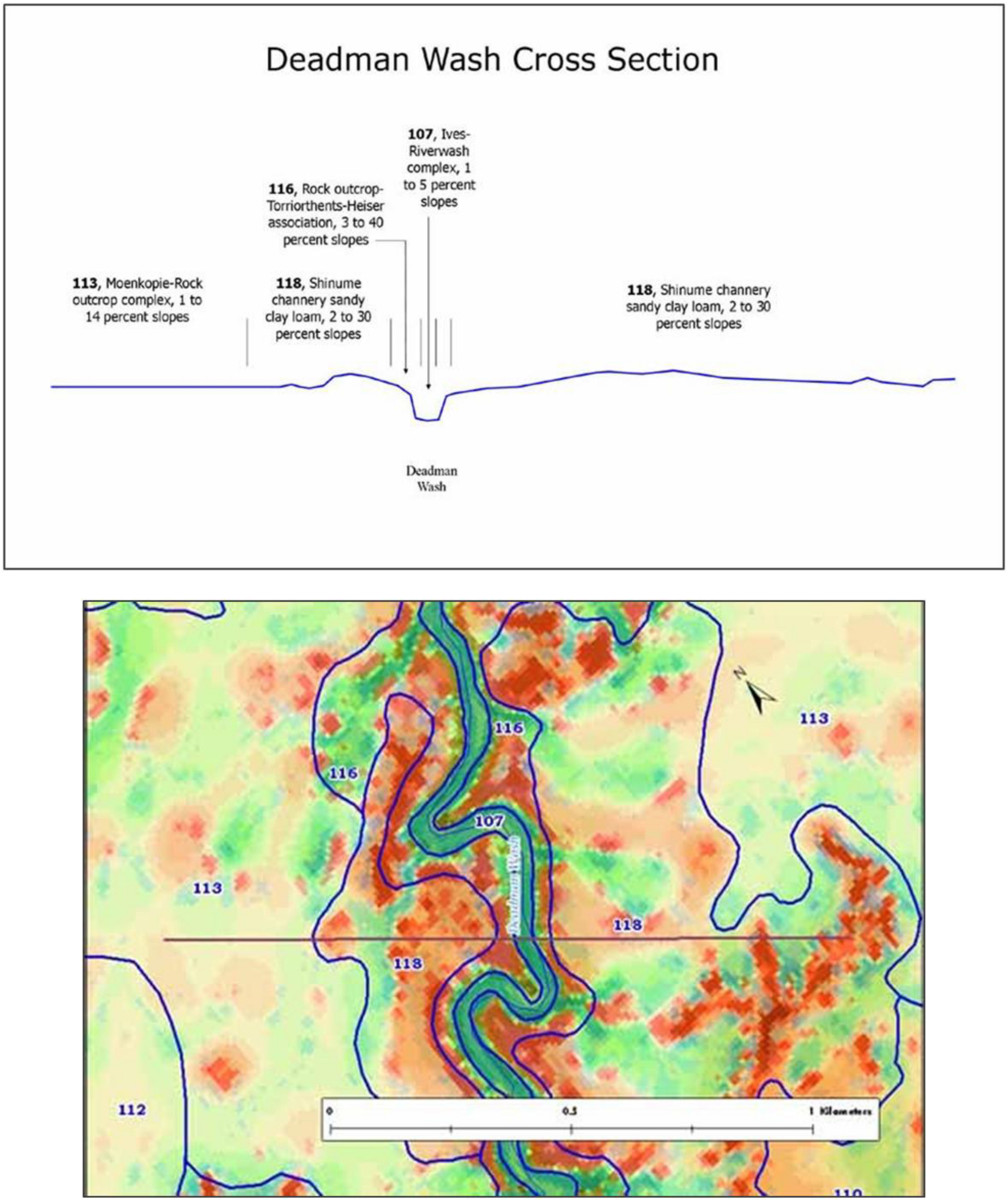


Figure 239.—Cross section and map of Deadman Wash. Deadman Wash is the park's major active canyon in the sandstone and shale of the Moenkopi Formation. Climbing dunes consisting of very deep coarse ash deposits occur in some locations within the canyon. Soils above the canyon rim tend to be very shallow because of erosion. The wash bottom is in map unit 107 (Ives-Riverwash complex, rarely flooded, 1 to 5 percent slopes), and the rocky side slopes are in map unit 116 (Rock outcrop-Torriorthents-Heiser association, 3 to 40 percent slopes). The areas of map unit 113 (Moenkopie-Rock outcrop complex, 1 to 14 percent slopes) and map unit 118 (Shinume channery sandy clay loam, 2 to 30 percent slopes) are bedrock-controlled. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points.

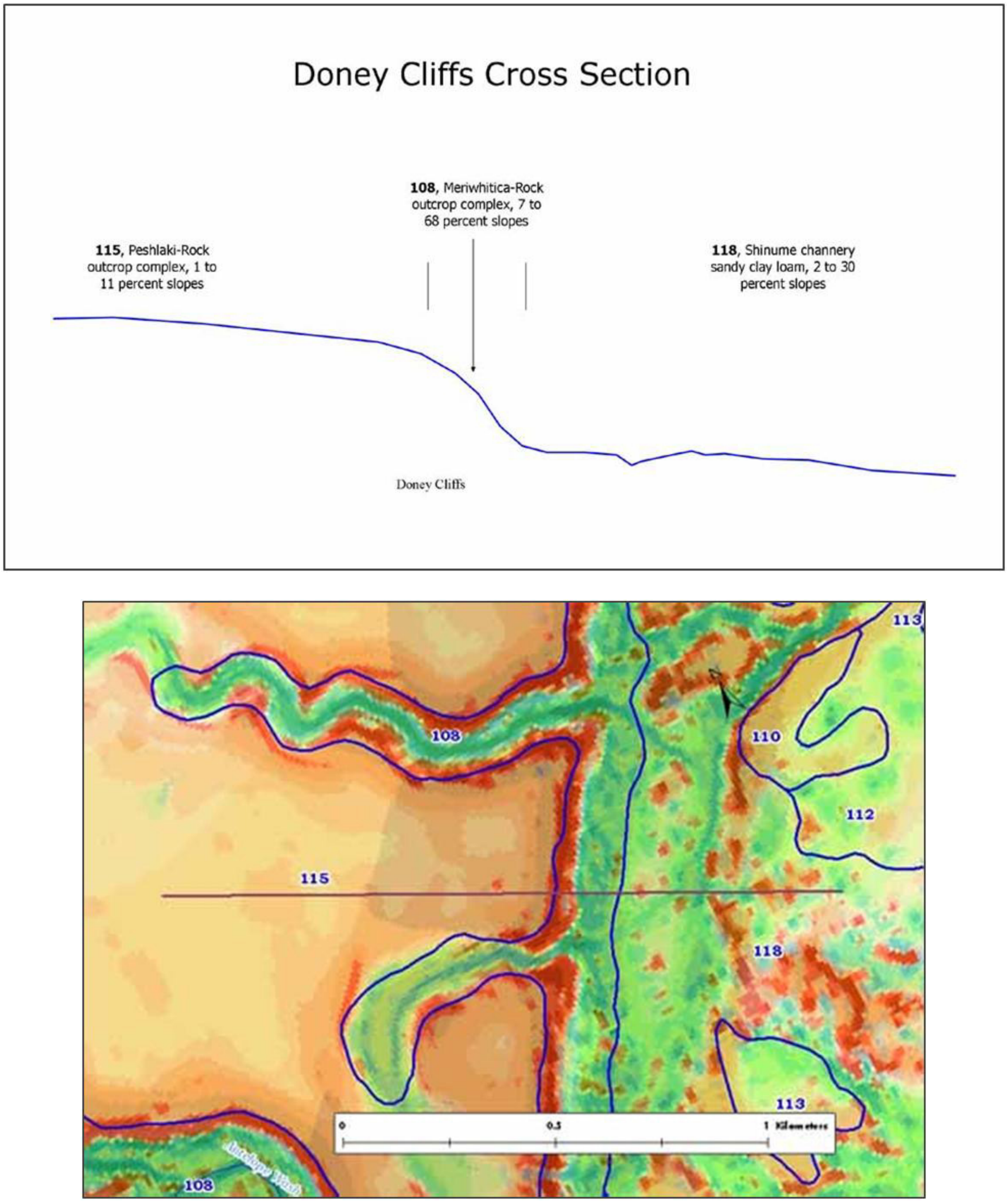


Figure 240.—Cross section and map of Doney Cliffs. Doney Cliffs are a normal fault cutting through the Kaibab Limestone. The area on the cliffs is in map unit 108 (Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes). The area above the cliffs, a highly erosive position, is in map unit 115 (Peshlaki-Rock outcrop complex, 1 to 11 percent slopes). The soil is a thin cover of Sunset Crater tephra over mostly barren limestone. Deposits of coarse ash may accumulate at the bottoms of washes below the rims of the cliff face. The area of map unit 118 (Shinume channery sandy clay loam, 2 to 30 percent slopes) is bedrock-controlled. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points.

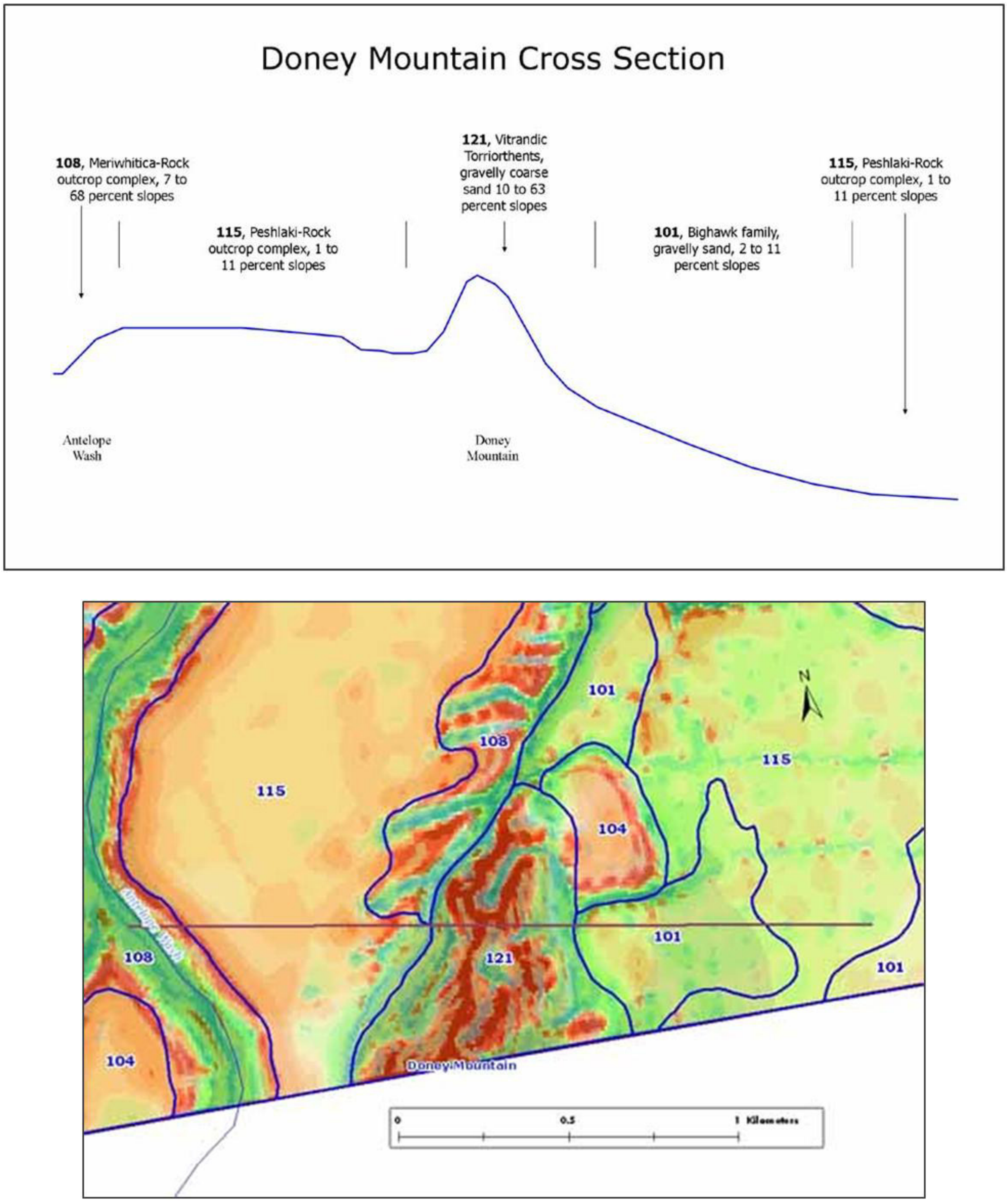


Figure 241.—Cross section and map of Doney Mountain. Doney Mountain is a cinder pile from a volcanic eruption 250,000 years ago. The soil in map unit 121 (Vitrandic Torriorthents, 10 to 63 percent slopes) is a cindery soil covering the slopes of Doney Mountain. Sunset Crater tephra covers toeslopes of the mountain and also areas of map unit 101 (Bighawk family gravelly sand, 2 to 11 percent slopes). Map unit 101 is an apron of older Doney tephra underlying younger Sunset Crater tephra. The ash below the mountain moved alluvially through sheet wash and rills. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points. The white area is outside the park boundary.

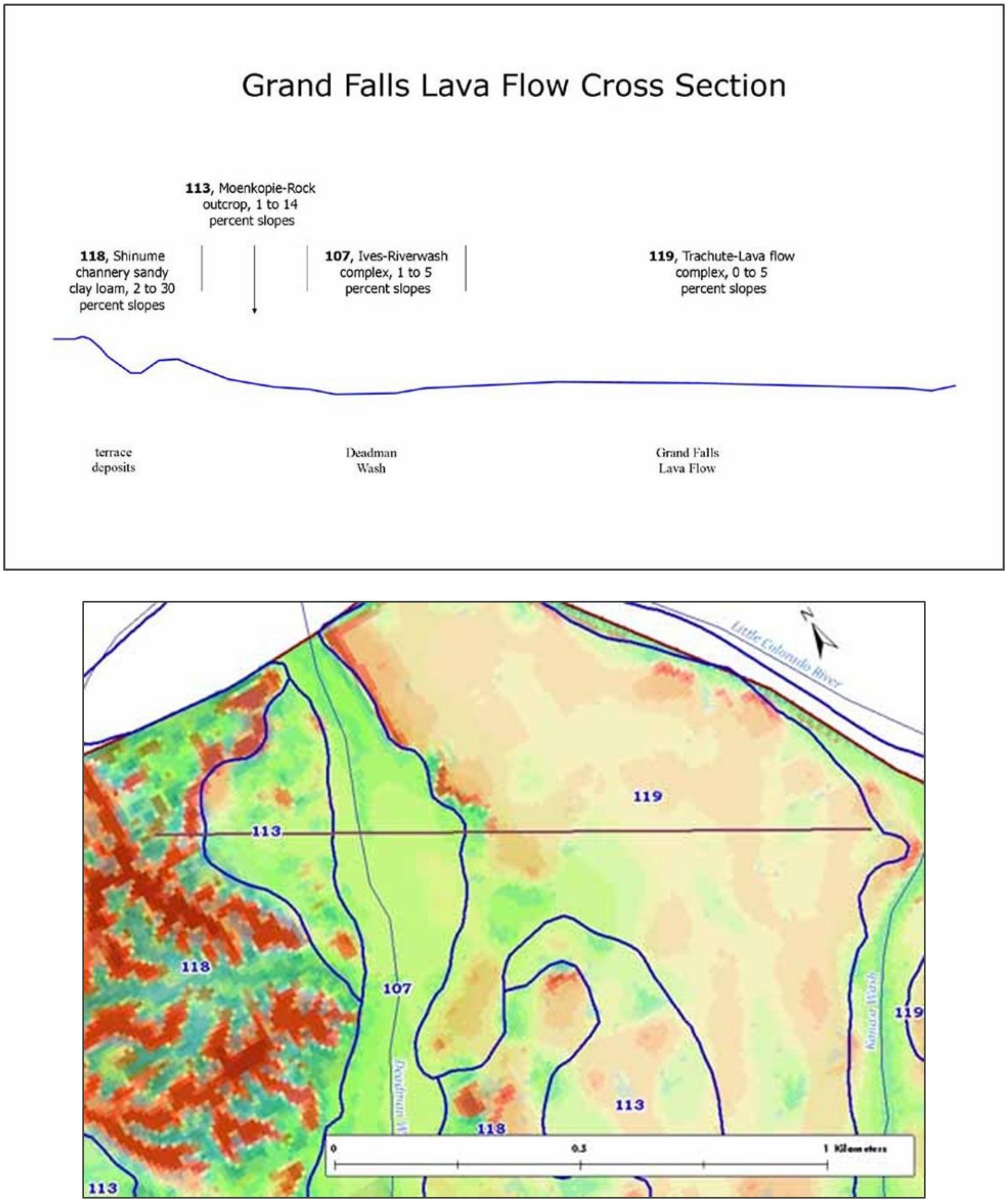
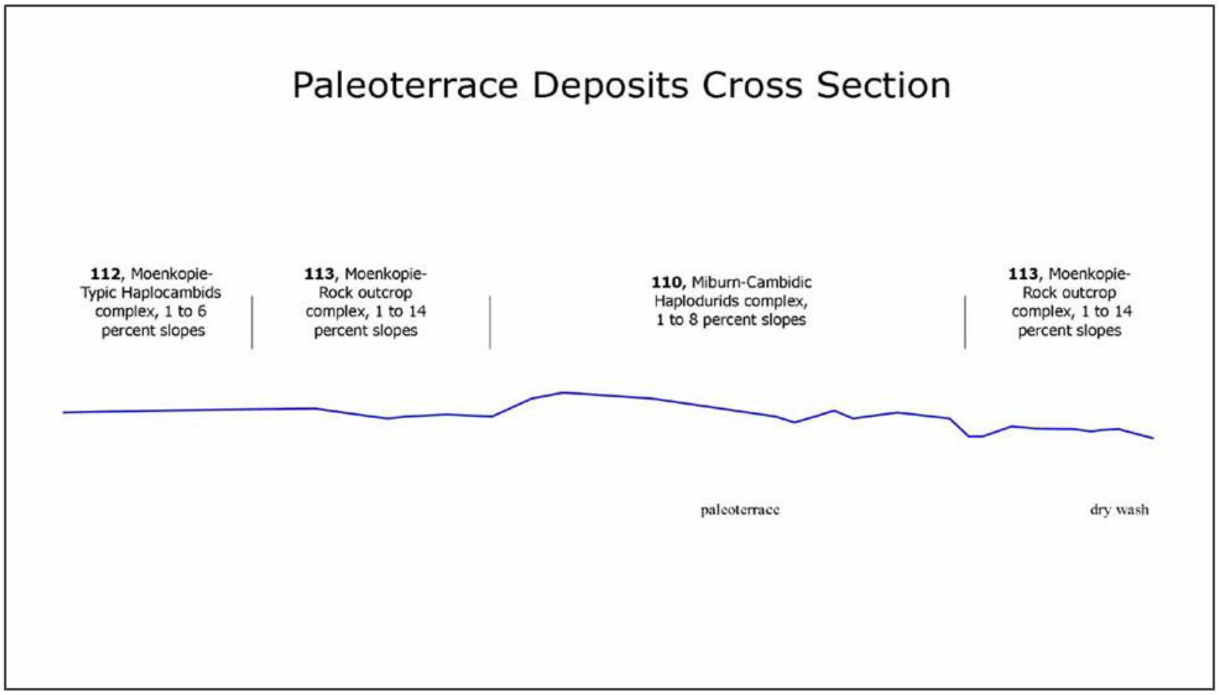


Figure 242.—Cross section and map of Grand Falls Lava Flow. This lava flow is the most recent lava flow within the park boundary. The bulk of the lava flow remains intact as unweathered basalt rock. In some places, sands from the Little Colorado River or Deadman Wash have been deposited on top of the flow during episodes of heavy rainfall. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points. The white areas are outside the park boundary.



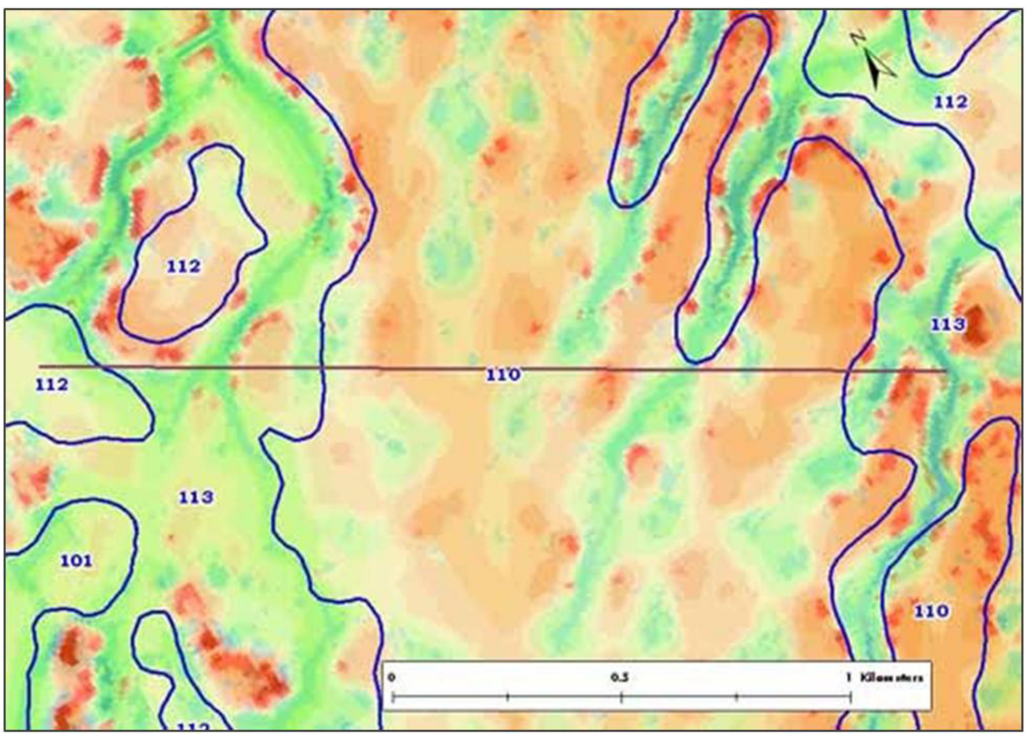


Figure 243.—Cross section and map of paleoterrace deposits in Wupatki Basin. An ancient river once flowed here and left small boulders and stones which are very resistant to weathering. The resistant beds cap hilltops within Wupatki Basin. Dunes of ash have filled low-lying places next to and on top of the paleoterrace. The paleoterrace is map unit 110 (Miburn-Cambidic Haplodurids complex, 1 to 8 percent slopes). Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points.

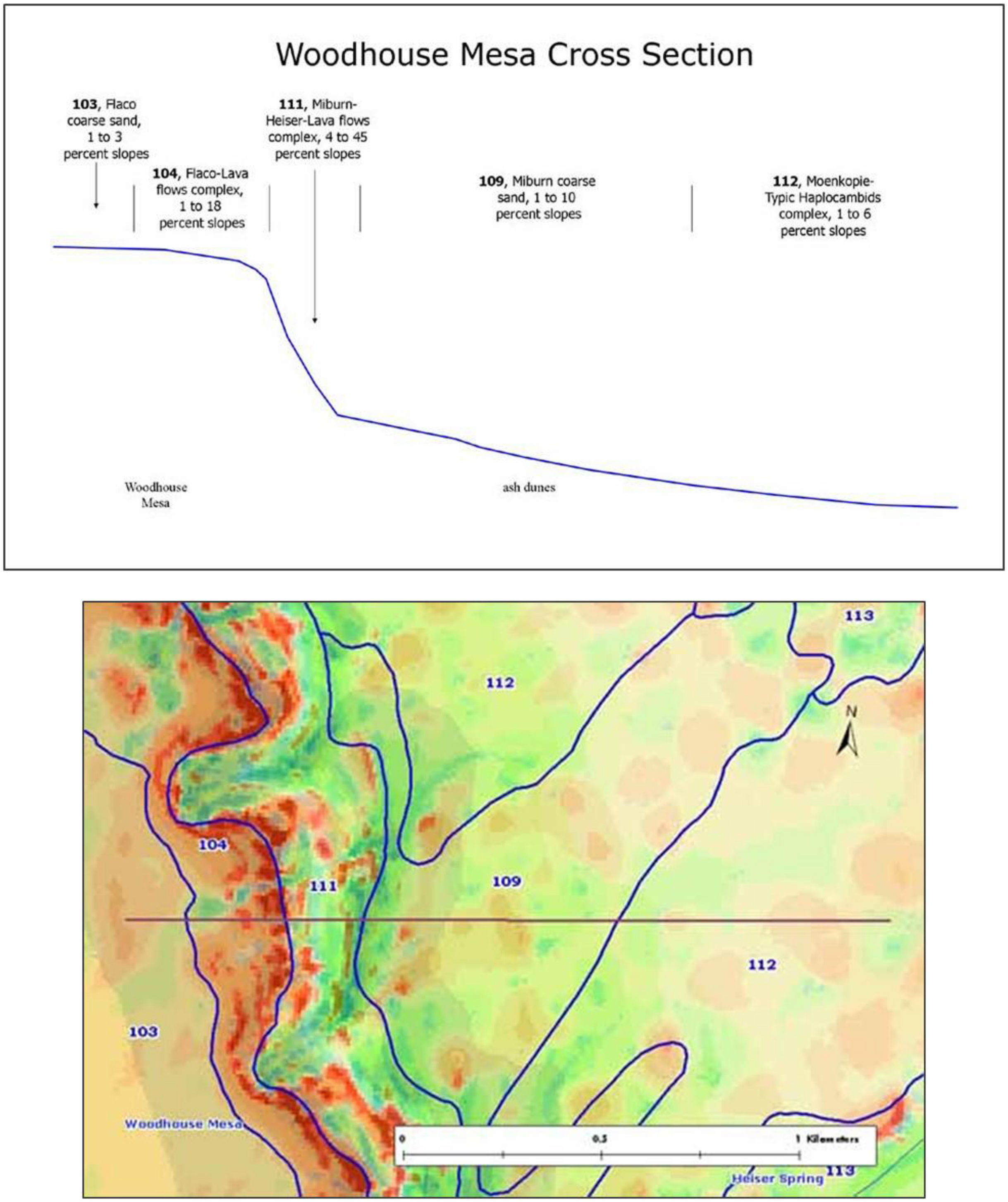


Figure 244.—Cross section and map of Woodhouse Mesa. This mesa was formed by one of the older lava flows within the park. Map unit 111 (Miburn-Heiser-Lava flows complex, 4 to 45 percent slopes) consists of climbing dunes of ash over older quartz sands with basalt colluvium in places. The ash came from the Sunset Crater eruption to the south. Map unit 109 (Miburn coarse sand, 1 to 10 percent slopes) consists of dunes of ash beneath Woodhouse Mesa that were scattered from southeasterly winds. Map unit 112 (Moenkopie-Typic Haplocambids complex, 1 to 6 percent slopes) has an increasingly thin cover of tephra over sedimentary residuum. Map colors relate to curvature. Green colors represent concave points on the topography, and brown represents convex points.

Figure 245.—Petrified wood from the Shinarump Member of the Chinle Formation.

Time

The age of deposits at Wupatki NM determines the vertical order of distribution. Since there are no intrusive deposits, the age of deposits can be sorted by vertical order. Younger deposits always overlie older ones. The oldest deposits in the park are sedimentary rock formations (fig. 245). Above the sedimentary formations are lava flows, which overlie one another in some places.

Sedimentary rocks weather to soft shallow soils that are susceptible to erosion. The more stable, older lava flows provide the best conditions for soil development and horizonation, including the formation of calcic and argillic horizons. A calcic horizon is an illuvial horizon in which secondary calcium and magnesium carbonates accumulate to a significant extent, exceeding 15 centimeters of 15 percent calcium carbonate equivalent. In semi-arid climates, precipitation is insufficient to leach bases and salts. Carbonates accumulate in large voids, often first as filaments along root channels and coatings on the bottoms of rock fragments. Over time and with continued deposition, the horizon becomes cemented with carbonates. Accumulations of carbonates impede soil infiltration at that point and reduce the available water-holding capacity. In stable areas west of the Citadel Ruins and on Woodhouse Mesa, soils of volcanic origin typically form calcic and argillic horizons. Argillic horizons have a significantly higher percentage of phyllosilicate clay than the overlying soil material and show evidence of clay illuviation. Illuviation is the downward movement of suspended clays into the soil profile with water infiltration.

The age of the tephra can be seen in the weathering of individual fragments (fig. 246). Fresh cinders of Sunset Crater material can be found in most places throughout the park overlying soils that formed from other sources. In some cases,

Figure 246.—Comparisons of three cinders with age. The cinders originating from Sunset Crater are freshly black and still glossy and show little weathering. The red cinders originating from older Doney Mountain are visibly oxidized on the surface and have few carbonate coats. The cinders from Big Hawk Valley are glazed in carbonates. These cinders are likely to be older still, but the age and source are unknown.

such as near Doney Mountain, it is easy to differentiate the fresh and glossy black Sunset Crater tephra from the older and oxidized red cinders of Doney Mountain. The Doney Mountain cinders are believed to be over 250,000 years old. In soils beneath Doney Mountain, soil horizons of the older material underlie horizons of the younger Sunset Crater material. Older cinders tend be oxidized and have some coatings of carbonates, especially on the bottoms of fragments. Carbonate coatings tend to occur at specific depths in the form of calcic horizons.

The even older tephra fragments found in Big Hawk Valley have become thoroughly coated with carbonates throughout soil profiles. The carbonate coatings have caused a loss of the beneficial effects of the tephra because pore spaces which might otherwise contain water have been thoroughly encased with carbonates. The source of these tan-colored tephra fragments is unknown. The fragments may have been transported to Wupatki NM either by eolian fallout, alluvial processes, or a combination of both. Based on aspects from various angles, the source area was probably near Colton Crater. The cinders may be a mixture from various sources of earlier volcanic explosions during the past 2 million or more years.

Soil stability is aided by parent material bearing clay minerals. Clay minerals help the soil to adhere to itself by possessing a surface charge. The surface charge of clay minerals not only helps the minerals to aggregate and resist erosion on gentle slopes but also helps clay to adhere to water. The presence of water in the soil helps plants to grow, and plant roots further stabilize the soil. Clay minerals have weathered out of older lava flows in the western half of the park.

Because there are many relationships between the soil-forming factors, a single event could initiate multiple responses that affect soil properties in several ways. If tephra is added, then moisture from rains may collect. As a result, plants, animals, and bacteria may flourish. Organic matter then accumulates at the surface, lowering temperatures and adding nutrients and biomass. New vegetation breaks surface winds, thus reducing drying conditions and encouraging animal life. However, if moisture becomes lost, then stability is reduced. Small fragments of ash then become vulnerable to wind erosion, carbonate buildup, and cementation. This further reduces moisture retention and organic matter retention.

It is easy to see how the enhancement of one soil property can lead to enhancements of other soil properties. Conversely, the degradation of one soil property can lead to the degradation of other soil properties. Wupatki NM is a unique example of how soil-forming factors and soil properties are interdependent.

Classification of the Soils

Soils are named and classified on the basis of physical and chemical properties in their horizons (layers). Color, texture, structure, and other properties of the soil to a depth of 2 meters are used to key the soil into a classification system. This system helps people to use soil information and also provides a common language for scientists.

Soils and their horizons differ from one another, depending on how and when they formed. Soil scientists use the five soil-forming factors to help predict where different soils may occur. The degree and expression of the soil horizons reflect the extent of interaction of the soil-forming factors with one or more of the soil-forming processes (Simonson, 1959).

When mapping soils, a soil scientist looks for areas with similar soil-forming factors to find similar soils. The properties of the soils are described. Soils with the same kind of properties are given taxonomic names. Soils are classified, mapped, and interpreted on the basis of various kinds of soil horizons and their arrangement. The distribution of soil orders corresponds with the general patterns of the soil-forming factors within the park.

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff, 1999 and 2010). 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. The categories are defined in the following paragraphs.

ORDER. Soil taxonomy at the highest hierarchical level identifies 12 soil orders. The names for the orders and taxonomic soil properties relate to Greek, Latin, or other root words that reveal something about the soil. 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 Aridisol.

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. Sixty-four suborders are recognized at the next level of classification. The last syllable in the name of a suborder indicates the order. An example is Cambid (*Camb*, indicating soil development with translocation or transformation of material, plus *id,* from Aridisol).

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. There are about 300 great groups. 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 Haplocambid (*Haplo,* meaning minimal horizon development, plus *cambid,* the suborder of the Aridisols that has a developed horizon of translocated or transformed material.)

SUBGROUP. There are more than 2,400 subgroups. Each great group has a typic subgroup. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Other subgroups are intergrades or extragrades. 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 *Vitrandic* identifies the subgroup that is comprised of volcanic deposits or has a layer of pyroclastic materials. An example is Vitrandic Haplocambids.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties for family placement are those of horizons below a traditional agronomic plow depth. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is ashy-skeletal, glassy, mesic Vitrandic Haplocambids.

SERIES. The soil series is the lowest category in the soil classification system. 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. An example is the Bighawk series, which is classified as ashy-skeletal, glassy, mesic Vitrandic Haplocambids. The Bighawk series is unique to Wupatki National Monument and was named after a valley near the soil type location.

Most parks are mapped to the series level. The names of soil series are selected by the soil scientists during the course of mapping. The series names are commonly geographic place names or are coined. Because of access limitations and soil variability, soils in some remote areas are classified at the great group or subgroup level.

Table 29 indicates the order, suborder, great group, subgroup, and family of the soil series in the park. Table 30 displays the classification as a key sorted by order.

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Glossary

Many of the terms relating to landforms, geology, and geomorphology are defined in more detail in the “National Soil Survey Handbook” (available in local offices of the Natural Resources Conservation Service or on the Internet).

`a`a lava. Hawaiian term for basaltic lava having a rough, jagged, clinkery surface and a vesicular interior.

`a`a lava flow. Basaltic lava flow dominated by `a`a lava that has a characteristically rough, jagged, clinkery surface.

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.

Agglutinate mound. A mound of cinders that has been carried away, as on a raft, from the original site of a cinder cone eruption.

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 fan. A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes. It is shaped like an open fan or a segment of a cone. The material was deposited by a stream at the place where it issues from a narrow mountain valley or upland valley or where a tributary stream is near or at its junction with the main stream. The fan is steepest near its apex, which points upstream, and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvium. Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Ash (volcanic). Unconsolidated, pyroclastic material less than 2 mm in all dimensions. Commonly called “volcanic ash.”

Ash flow. (Note: This term is not preferred; see Pyroclastic flow and Pyroclastic surge.) A highly heated mixture of volcanic gases and ash, traveling down the flank of a volcano or along the surface of the ground; produced by the explosive disintegration of viscous lava in a volcanic crater or by the explosive emission of gas-charged ash from a fissure or group of fissures. The solid materials contained in a typical ash flow are generally unsorted and ordinarily include volcanic dust, pumice, scoria, and blocks in addition to ash. Also called pyroclastic flow.

Aspect. The direction toward which a slope faces. Also called slope aspect.

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
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Backslope. The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Badland. A landscape that is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes and narrow interfluves. Badlands develop on surfaces that have little or no vegetative cover overlying unconsolidated or poorly cemented materials (clays, silts, or sandstones) with, in some cases, soluble minerals, such as gypsum or halite.

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.

Base slope (geomorphology). A geomorphic component of hills consisting of the concave to linear (perpendicular to the contour) slope that, regardless of the lateral shape, forms an apron or wedge at the bottom of a hillside dominated by colluvium and slope-wash sediments (for example, slope alluvium).

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

Block field. A thin accumulation of typically angular stone blocks that has only coarse fragments in the upper part and overlies solid or weathered bedrock, colluvium, or alluvium where there is not a cliff or ledge above as an apparent source. Block fields occur on high mountain slopes above the tree-line or in polar or paleo-periglacial regions. They are most extensive along slopes parallel to the contour; and they generally occur on slopes of less than 5 percent.

Block glide (mass movement). A slow type of landslide in which largely intact units (blocks) of rock or soil slide downslope along a relatively planar surface, such as a bedding plane, without any significant distortion of the original mass; a type of translational rock slide.

Block lava. Lava having a surface of angular blocks that is similar to \`a\`a lava but has fragments that are larger and more regular in shape, somewhat smoother, and less vesicular. Compare to \`a\`a lava, pahoehoe lava, and pillow lava.

Block lava flow. A lava flow dominated by block lava. Compare to \`a\`a lava flow and pahoehoe lava flow.

Bottom land. An informal term loosely applied to various portions of a flood plain.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Bouldery. Refers to a soil containing boulders in numbers that interfere with or prevent tillage.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caldera. A large, more or less circular depression, which was formed by explosion and/or collapse and which surrounds a volcanic vent or vents. Its diameter is many times greater than that of the included vent or vents.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Canyon. A long, deep, narrow 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-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.

Channery soil material. Soil material that has, 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.

Cinder cone. A conical hill formed by the accumulation of cinders and other pyroclastics, typically basaltic or andesitic in composition. Slopes generally exceed 20 percent.

Cinders. Uncemented vitric, vesicular, pyroclastic material that is more than 2.0 millimeters long in at least one dimension and has an apparent specific gravity (including vesicles) of more than 1.0 and less than 2.0.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

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 has 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.

COLE (coefficient of linear extensibility). See Linear extensibility.

Colluvium. Unconsolidated, unsorted earth material that is transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Common resource area. See Land resource units and Major land resource areas.

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.

Concretions. See Redoximorphic features.

Conglomerate. A coarse grained, clastic sedimentary 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.

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.

Corrosion (geomorphology). A process of erosion whereby rocks and soil are removed or worn away by natural chemical processes, especially by the solvent action of running water, but also by other reactions, such as hydrolysis, hydration, carbonation, and oxidation.

Corrosion (soil survey interpretations). Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Cumulization (soil formation). The process in which fine grains accumulate on the surface from wind or water action and simultaneously penetrate the upper portion of a soil profile with precipitation events.

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.

Densic materials. Materials that are relatively unaltered and have a noncemented rupture-resistance class. The bulk density or the organization is such that roots cannot enter, except in cracks. These are mostly earthy materials, such as till, volcanic mudflows, and some mechanically compacted materials, such as mine spoils. Some noncemented rocks can be densic materials if they are dense or resistant enough to keep roots from entering, except in cracks.

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.

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.

Drainageway. A general term for a course or channel along which water moves in draining an area. A term restricted to relatively small, linear depressions that at some time move concentrated water and either do not have a defined channel or have only a small defined channel.

Dune. A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand). It is either barren and capable of movement from place to place or is covered and stabilized with vegetation but still retaining its characteristic shape.

Earthy fill. See Mine spoil.

Ecological site. An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological 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 ecological sites in kind and/or proportion of species or in total production.

Eolian deposit. Sand-, silt-, or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

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.

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 surface. A land surface shaped by the action of erosion, especially by running water.

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. Most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Extrusive. Term used for igneous rocks and sediments derived from deep-seated molten matter (magma), deposited and cooled on the earth's surface. Examples are lava flows and tephra deposits.

Fan remnant. A general term for landforms that are the remaining parts of older fan landforms, such as alluvial fans, that have been either dissected or partially buried.

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.

Fissure vent. An opening in the earth's surface of a volcanic conduit in the form of a crack or fissure rather than a localized crater; a roughly linear crack or area along which lava, generally mafic and of low viscosity, wells up to the surface, usually without any explosive activity. The results include an extensive lava plateau, such as the Columbia River Plateau.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. The nearly level plain that borders a stream and is subject to flooding unless protected artificially.

Flood-plain step. An essentially flat, terrace-like alluvial surface within a valley that is frequently covered by floodwater from the present stream; any approximately horizontal surface still actively modified by fluvial scour and/or deposition. Flood-plain steps may occur individually or as a series of steps.

Fluvial. Of or pertaining to rivers or streams; produced by stream or river action.

Foothills. A region of steeply sloping hills that fringes a mountain range or high-plateau escarpment. The hills have relief of as much as 1,000 feet (300 meters).

Footslope. The concave surface at the base of a hillslope. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

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.

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 has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Ground water. Water filling all the unblocked pores of the material below the water table.

Gully. A small channel with steep sides caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. 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.

Hard to reclaim (in tables). Reclamation is difficult after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

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 slope (geomorphology). A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway. The overland waterflow is converging.

Hill. A generic term for an elevated area 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. Slopes are generally more than 15 percent. The distinction between a hill and a mountain is arbitrary and may depend on local usage.

Hillslope. A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of a hill.

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:

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.

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.

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.

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.

Interfluve (geomorphology). A geomorphic component of hills consisting of the uppermost, comparatively level or gently sloping area of a hill; shoulders of backwearing hillslopes can narrow the upland or can merge, resulting in a strongly convex shape.

Intermittent stream. A stream, or reach of a stream, that does not flow year-round but that is commonly dry for 3 or more months out of 12 and whose channel is generally below the local water table. It flows only during wet periods or when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Iron depletions. See Redoximorphic features.

K_{sat}. Saturated hydraulic conductivity. (See Permeability.)

Lacustrine deposit. Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Land resource units (LRUs). The basic units from which major land resource areas (MLRAs) are determined. LRUs are created by subdividing MLRAs according to resources, soil groups, hydrologic units, topography, other landscape features, and considerations affecting land use and soil and water conservation treatment. Also referred to as common resource area (CRA).

Landslide. A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials caused by gravitational forces; the movement may or may not involve saturated materials. 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.

Lava. A general term for a molten extrusive; also the rock solidified from it.

Lava channel. See Lava trench.

Lava field. An area covered primarily by lava flows whose terrain can be rough and broken or relatively smooth; it can include vent structures (e.g., small cinder cones and spatter cones), surface flow structures (e.g., pressure ridges and tumuli), and small, intermittent areas covered with pyroclastics.

Lava flow. A solidified body of rock formed from the lateral, surficial outpouring of molten lava from a vent or fissure. It is commonly lobate in form. Compare to \`a\`a lava flow, lava flow unit, and pahoehoe lava flow.

Lava flow unit. A separate, distinct lobe of lava that issues from the main body of a lava flow; a specific outpouring of lava a few centimeters to several meters thick and of variable lateral extent that forms a subdivision within a single flow. A series of overlapping lava flow units comprise a single lava flow. Also called flow unit.

Lava plain. A broad area of nearly level land that can be localized but is commonly hundreds of square kilometers in extent and that is covered by a relatively thin succession of primarily basaltic lava flows resulting from fissure eruptions.

Lava plateau. A broad elevated tableland or flat-topped highland that may be localized but commonly is many hundreds or thousands of square kilometers in extent and that is underlain by a thick succession of basaltic lavaflows resulting from fissure eruptions (e.g., the Columbia River Plateau).

Lava trench. A natural surface channel in a lava flow that never had a roof and was formed by the surficial draining of molten lava rather than by erosion from running water. Also called lava channel.

Lava tube. A natural, hollow tunnel beneath the surface of a solidified lava flow through which the lava flow was fed. The tunnel was left empty when the molten lava drained out.

Leaching. The removal of soluble material from soil or other material by percolating water.

Ledge. A narrow shelf or projection of rock, much longer than wide, formed on a rock wall or cliff face,

Linear extensibility. Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^{1}/_{3}$- or $^{1}/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

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.

Low strength. The soil is not strong enough to support loads.

Mafic rock. A general term for igneous rock composed chiefly of one or more ferromagnesian, dark-colored minerals; also said of those minerals.

Major land resource areas (MLRAs). These are geographically associated land resource units (LRUs). Identification of these large areas is important in statewide agricultural planning as well as in interstate, regional, and national planning.

Marl. An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under freshwater lacustrine conditions but also in more saline environments.

Mass movement. A generic term for the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress.

Masses. See Redoximorphic features.

Mawae (colloquial Hawaiian term). A natural surface channel that commonly occurs near the middle of an \`a\`a lava flow and that formed by the surficial draining of molten lava rather than by erosion from running water; a type of lava trench.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat-topped and commonly isolated landmass bounded by steep slopes or precipitous cliffs and capped by layers of resistant, nearly horizontal rocky material. The summit width is characteristically greater than the height of the bounding escarpments.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth's crust. Nearly all such rocks are crystalline.

Mine spoil. An accumulation of displaced earthy material, rock, or other waste material removed during mining or excavation. Also called earthy fill.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. A kind of map unit 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.

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 generic term for an elevated area of the land surface, rising more than 1,000 feet (300 meters) 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. Mountains are formed primarily by tectonic activity and/or volcanic action but can also be formed by differential erosion.

Mudstone. A blocky or massive, fine grained sedimentary rock in which the proportions of clay and silt are approximately equal. Also, a general term for such material as clay, silt, claystone, siltstone, shale, and argillite and that should be used only when the amounts of clay and silt are not known or cannot be precisely identified.

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.

Neutral soil. A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules. See Redoximorphic features.

Nose slope (geomorphology). A geomorphic component of hills consisting of the projecting end (laterally convex area) of a hillside. The overland waterflow is predominantly divergent. Nose slopes consist dominantly of colluvium and slope-wash sediments (for example, slope alluvium).

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

Pahoehoe lava. Basaltic lava that has a characteristically smooth, billowy or rope-like surface and vesicular interior.

Pahoehoe lava flow. Basaltic lava flow that has a characteristically smooth, billowy or rope-like surface.

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.

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 movement of water through the soil.

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:

Impermeable	less than 0.0015 inch
Very slow	0.0015 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

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

Pillow lava. A general term for lava displaying pillow structure (discontinuous, close-fitting, bun-shaped or ellipsoidal masses generally less than 1 meter in diameter). It is considered to have formed in a subaqueous environment. Such lava is typically basaltic or andesitic.

Pillow lava flow. A lava flow or body displaying pillow structure and considered to have formed in a subaqueous environment; typically basaltic or andesitic in composition. Compare to block lava flow and pahoehoe lava flow.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plateau (geomorphology). A comparatively flat area of great extent and elevation; specifically, an extensive land region that is considerably elevated (more than 100 meters) above the adjacent lower-lying terrain, is commonly limited on at least one side by an abrupt descent, and has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

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.

Pore linings. See Redoximorphic features.

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.

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.

Pumice (soil science). Rock fragments that are 2 millimeters in diameter or coherent rock layers (pumice flow) composed of light-colored, vesicular, glassy rock commonly having the composition of rhyolite. The material commonly has a specific gravity of less than 1.0 and is thereby sufficiently buoyant to float on water.

Pumice (geology). Rock fragments or coherent rock layers (pumice flow) composed of light-colored, vesicular, glassy rock commonly having the composition of rhyolite. The material commonly has a specific gravity of less than 1.0 and is thereby sufficiently buoyant to float on water. There are no size restrictions.

Pyroclastic. Pertaining to clastic rock particles produced by explosive, aerial ejection from a volcanic vent. Such materials may accumulate on land or under water. Compare to volcaniclastic.

Pyroclastic flow. A fast-moving current of pyroclastic material, usually very hot, composed of a mixture of gasses and a variety of pyroclastic particles (such as ash, pumice, scoria, and lava fragments). It is produced by the explosive disintegration of viscous lava in a volcanic crater or by the explosive emission of gas-charged ash from a fissure and tends to follow topographic lows (e.g., valleys) as it moves. This term is used in a more general sense than ash flow.

Pyroclastic surge. A low-density, dilute, turbulent pyroclastic flow, usually very hot, composed of a generally unsorted mixture of gases, ash, pumice, and dense rock fragments that travels across the ground at high speeds and is less constrained by topography than a pyroclastic flow. There are several types of pyroclastic surges, including base surge and ash-cloud-surge.

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.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed as 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. See Redoximorphic features.

Redoximorphic depletions. See Redoximorphic features.

Redoximorphic features. Redoximorphic features are associated with wetness and result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese are oxidized and precipitated, they form either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redoximorphic processes in a soil may result in redoximorphic features that are defined as follows:

1. Redoximorphic concentrations.—These are zones of apparent accumulation of iron-manganese oxides, including:

A. Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure; *and*

B. Masses, which are noncemented concentrations of substances within the soil matrix; *and*

C. Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.

2. Redoximorphic depletions.—These are zones of low chroma (chromas less than those in the matrix) where either iron-manganese oxides alone or both iron-manganese oxides and clay have been stripped out, including:

A. Iron depletions, i.e., zones that contain low amounts of iron and manganese oxides but have a clay content similar to that of the adjacent matrix; *and*

B. Clay depletions, i.e., zones that contain low amounts of iron, manganese, and clay (often referred to as silt coatings or skeletans).

3. Reduced matrix.—This is a soil matrix that has low chroma *in situ* but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

Reduced matrix. See Redoximorphic features.

Relief. The relative difference in elevation between the upland summits and the lowlands or valleys of a given region.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as bedrock disintegrated in place.

Riser. The vertical or steep side slope (e.g., escarpment) of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural, steplike landforms, such as successive stream terraces.

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.

Rock varnish. A thin, dark, shiny film or coating, composed of iron oxide accompanied by traces of manganese oxide and silica, that formed on the surfaces of pebbles, boulders, and other rock fragments. It commonly occurs on rock outcrops in arid regions. It is thought to be caused by exudation of mineralized solutions from within and deposition by evaporation on the surface.

Rocky. A term used in the phase name of a soil map unit to indicate areas that have between 0.01 and 10 percent rock outcrop.

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.

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.

Saturated hydraulic conductivity (K_{sat}). See Permeability.

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.

Scarp. An escarpment, cliff, or steep slope of some extent along the margin of a plateau, mesa, terrace, or structural bench. A scarp may be of any height.

Scarp slope. The relatively steeper face of a cuesta, facing in a direction opposite to the dip of the strata.

Scoria (soil science). Vesicular rock fragments that are more than 2 millimeters in size in at least one dimension and have a specific gravity of more than 2.0, or a cindery crust of such material on the surface of andesitic or basaltic lava. The vesicular nature is due to the escape of volcanic gases before solidification. It is typically heavier, darker, and more crystalline than pumice.

Scoria (geology). Vesicular rock fragments that have a specific gravity of more than 2.0 or a cindery crust of such material on the surface of andesitic or basaltic lava. There are no size restrictions. The vesicular nature is due to the escape of volcanic gases before solidification. It is typically heavier, darker, and more crystalline than pumice.

Scree. A collective term for an accumulation of coarse rock debris or a sheet of coarse debris mantling a slope. Scree is not synonymous with talus as scree includes loose, coarse fragments on slopes without cliffs.

Scree slope. A portion of a hillside or mountain slope mantled by scree and lacking an up-slope rockfall source (i.e., cliff). Compare to scree and talus.

Sedimentary rock. A consolidated deposit of clastic particles, chemical precipitates,or organic remains accumulated at or near the surface of the earth under normal low temperature and pressure conditions. Sedimentary rocks include consolidated equivalents of alluvium, colluvium, drift, and eolian, lacustrine, and marine deposits. Examples are sandstone, siltstone, mudstone, claystone, shale, conglomerate, limestone, dolomite, and coal.

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 that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shoulder. The convex, erosional surface near the top of a hillslope. A shoulder is a transition from summit to backslope.

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.

Side slope (geomorphology). A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel. Side slopes are dominantly colluvium and slope-wash sediments.

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. An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

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.

Slickensides (pedogenic). Grooved, striated, and/or glossy (shiny) slip faces on structural peds, such as wedges; produced by shrink-swell processes, most commonly in soils that have a high content of expansive clays.

Slick rock. A barren, highly smoothed and subrounded bedrock pavement with considerable, irregular topography sculpted primarily by wind in an arid climate; a type of rock outcrop common on the top of massive sandstone bedrock (e.g., Navajo, Windgate, and Kayenta Formations), especially on summits of ridges and near the leading edge of plateaus, mesas, and cuestas.

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.

Slope alluvium. Sediment gradually transported down the slopes of mountains or hills primarily by nonchannel alluvial processes (i.e., slope-wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of rock fragments and may be separated by stone lines. Burnished peds and sorting of rounded or subrounded pebbles or cobbles distinguish these materials from unsorted colluvial deposits.

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.

Sodium adsorption ratio (SAR). A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

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 and by the passage 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.

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.

Stream terrace. One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream; represents the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition.

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 grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summit. The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

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."

Talus. Rock fragments of any size or shape (commonly coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of such loose broken rock formed chiefly by falling, rolling, or sliding.

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 (geomorphology). A steplike surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake, or seashore. The term is usually applied both to the relatively flat summit surface (tread) that was cut or built by stream or wave action and to the steeper descending slope (scarp or riser) that has graded to a lower base level of erosion.

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."

Toeslope. The gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Tread. The flat to gently sloping, topmost, laterally extensive slope of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural steplike landforms, such as successive stream terraces.

Tuff. A generic term for any consolidated or cemented deposit that is 50 percent volcanic ash (less than 2 millimeters in size). Various types of tuff are distinguished by composition: acidic tuff is predominantly composed of acidic particles and basic tuff is predominantly composed of basic particles.

Upland. An informal, general term for the higher ground of a region, in contrast with a low-lying adjacent area, such as a valley or plain, or for land at a higher elevation than the flood plain or low stream terrace.

Volcanic breccia. A volcaniclastic rock composed mostly of angular rock fragments larger than 2 millimeters. This term is not synonymous with pyroclastic breccia as volcanic breccia forms in different ways.

Volcanic cone. A conical hill of lava and/or pyroclastics that is built up around a volcanic vent.

Volcanic dome. A steep-sided, rounded extrusion of highly viscous lava squeezed out from a volcano and forming a dome-shaped or bulbous mass of congealed lava above and around the volcanic vent.

Volcanic field. A more or less well defined area that is covered with volcanic rocks of much more diverse lithology and distribution than a lava field or that is so modified by age and erosion that its original topographic configuration, composition, and extent are uncertain.

Volcaniclastic. Pertaining to the entire spectrum of fragmental materials with a preponderance of clasts of volcanic origin. The term includes not only pyroclastic materials but also epiclastic deposits derived from volcanic source areas by normal processes of mass movement and stream erosion. Examples are welded tuff and volcanic breccia.

Weathering. All physical disintegration, chemical decomposition, and biologically induced changes in rocks or other deposits at or near the earth's surface by atmospheric or biologic agents or by circulating surface waters but involving essentially no transport of the altered 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.

Tables

Table 1.—Temperature and Precipitation

(Recorded in the period 1940-2013 at Wupatki National Monument, Arizona)

Month	Temperature (degrees C)						Precipitation (centimeters)				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 may have: Maximum higher than--	2 years in 10 may have: Minimum lower than--	Average number of growing degree days*	Average	2 years in 10 may have: Less than--	2 years in 10 may have: More than--	Average number of days with 0.10 inch or more	Average snow-fall
January--	8.4	-4.1	2.1	19	-14	2	1.12	0.05	1.83	1	3.8
February-	12.6	-1.6	5.5	21	-12	10	1.07	0.18	1.37	1	2.8
March----	17.1	1.5	9.3	27	-8	73	1.40	0.10	2.39	2	2.5
April----	21.9	5.5	13.7	31	-3	226	0.91	0.15	1.40	1	0.5
May------	27.3	10.2	18.8	36	2	491	0.91	0.00	1.32	1	0.0
June-----	33.2	15.4	24.4	39	6	776	0.69	0.00	0.97	1	0.0
July-----	35.1	18.8	26.9	41	13	946	3.51	1.52	4.93	4	0.0
August	33.2	17.4	25.3	38	11	855	3.99	2.01	5.61	4	0.0
September	29.8	13.7	21.7	37	6	633	2.36	0.38	3.58	3	0.0
October--	22.9	7.3	15.1	32	-2	300	1.80	0.13	2.61	2	0.0
November-	14.7	0.7	7.7	24	-8	38	1.22	0.23	1.37	1	1.3
December-	8.3	-3.8	2.2	19	-13	2	1.30	0.13	2.08	2	5.3
Yearly:											
Average	22.1	6.8	14.4	---	---	---	---	---	---	---	---
Extreme	---	---	---	41	-16	---	---	---	---	---	---
Total--	---	---	---	---	---	4,353	20.27	14.76	9.12	23	16.3

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (10 degrees C).

Table 2.—Freeze Dates in Spring and Fall

(Recorded in the period 1940-2013 at Wupatki National Monument, Arizona)

Probability	Temperature (degrees C)		
	-4 or lower	-2 or lower	0 or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 4	Apr. 13	May 9
2 years in 10 later than--	Mar. 30	Apr. 8	Apr. 29
5 years in 10 later than--	Mar. 8	Mar. 27	Apr. 16
First freezing temperature in fall:			
1 year in 10 earlier than--	Nov. 2	Oct. 28	Oct. 15
2 years in 10 earlier than--	Nov. 12	Oct. 30	Oct. 20
5 years in 10 earlier than--	Nov. 21	Nov. 9	Oct. 29

Table 3.—Growing Season

(Recorded in the period 1940-2013 at Wupatki National Monument, Arizona)

Probability	Daily minimum temperature during growing season (degrees C)		
	-4 or higher	-2 or higher	0 or higher
	Days	Days	Days
9 years in 10	224	199	169
8 years in 10	231	209	178
5 years in 10	260	229	194
2 years in 10	280	244	219
1 year in 10	289	258	230

Table 4.—Soil Legend

Map unit symbol and map unit name	Components in map unit	Percent of map unit
100:		
Bighawk gravelly sandy loam, 1 to 5 percent slopes	Bighawk	100
101:		
Bighawk family gravelly sand, 2 to 11 percent slopes	Bighawk	85
102:		
Chedeski very gravelly sandy loam, 0 to 6 percent slopes	Chedeksi	90
103:		
Flaco extremely gravelly coarse sand, 1 to 3 percent slopes	Flaco	90
104:		
Flaco-Lava flows complex, 1 to 18 percent slopes	Flaco	75
	Lava flows	10
105:		
Flaco-Pocum complex, 1 to 3 percent slopes	Flaco	65
	Pocum	25
106:		
Gish very gravelly coarse sand, 0 to 0.4 percent slopes	Gish	90
107:		
Ives-Riverwash complex, rarely flooded, 1 to 5 percent slopes	Ives	60
	Riverwash	20
108:		
Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes	Meriwhitica	75
	Rock outcrop	25
109:		
Miburn coarse sand, 1 to 10 percent slopes	Miburn	85
110:		
Miburn-Cambidic Haplodurids complex, 1 to 8 percent slopes	Miburn	45
	CambidiC Haplodurids	40
111:		
Miburn-Heiser-Lava flows complex, 4 to 45 percent slopes	Miburn	50
	Heiser	35
	Lava flows	10
112:		
Moenkopie-Typic Haplocambids complex, 1 to 6 percent slopes	Moenkopie	45
	Typic Haplocambids	40
113:		
Moenkopie-Rock outcrop complex, 1 to 14 percent slopes	Moenkopie	70
	Rock outcrop	20
114:		
Nalakihu loamy sand, 0 to 4 percent slopes	Nalakihu	85

Table 4.-Soil Legend—Continued

Map unit symbol and map unit name	Components in map unit	Percent of map unit
115:		
Peshlaki-Rock outcrop complex, 1 to 11 percent slopes	Peshlaki	75
	Rock outcrop	10
116:		
Rock outcrop-Typic Torriorthents-Heiser association, 3 to 40 percent slopes	Rock outcrop	35
	Typic Torriorthents	30
	Heiser	25
117:		
Sandy, Typic Torriorthents, 1 to 15 percent slopes	Sandy, Typic Torriorthents	100
118:		
Shinume channery sandy clay loam, 2 to 30 percent slopes	Shinume	85
119:		
Trachute-Lava flows complex, very rarely flooded, 0 to 5 percent slopes	Trachute	80
	Lava flows	10
120:		
Tsosie very gravelly coarse sand, 1 to 5 percent slopes	Tsosie	85
121:		
Vitrandic Torriorthents, 10 to 63 percent slopes	Vitrandic Torriorthents	100

Table 5.—Acres, Hectares, and Proportionate Extent of the Map Units

Map symbol	Map unit name	Acres	Hectares	Percent
100	Bighawk gravelly sandy loam, 1 to 5 percent slopes	1,195	484	3.4
101	Bighawk family gravelly sand, 2 to 11 percent slopes	243	98	0.7
102	Chedeski very gravelly sandy loam, 0 to 6 percent slopes	1,418	574	4.0
103	Flaco extremely gravelly coarse sand, 1 to 3 percent slopes	1,109	449	3.1
104	Flaco-Lava flows complex, 1 to 18 percent slopes	3,521	1,426	9.9
105	Flaco-Pocum complex, 1 to 3 percent slopes	995	403	2.8
106	Gish very gravelly coarse sand, 0 to 0.4 percent slopes	103	42	0.3
107	Ives-Riverwash complex, rarely flooded, 1 to 5 percent slopes	404	164	1.1
108	Meriwhitica-Rock outcrop complex, 7 to 68 percent slopes	972	394	2.7
109	Miburn coarse sand, 1 to 10 percent slopes	357	145	1.0
110	Miburn-Cambidic Haplodurids complex, 1 to 8 percent slopes	1,222	495	3.4
111	Miburn-Heiser-Lava flows complex, 4 to 45 percent slopes	367	149	1.0
112	Moenkopie-Typic Haplocambids complex, 1 to 6 percent slopes	2,895	1,172	8.2
113	Moenkopie-Rock outcrop complex, 1 to 14 percent slopes	6,856	2,777	19.3
114	Nalakihu loamy sand, 0 to 4 percent slopes	221	90	0.6
115	Peshlaki-Rock outcrop complex, 1 to 11 percent slopes	8,478	3,434	23.9
116	Rock outcrop-Typic Torriorthents-Heiser association, 3 to 40 percent slopes	1,451	588	4.1
117	Sandy, Typic Torriorthents, 1 to 15 percent slopes	285	115	0.8
118	Shinume channery sandy clay loam, 2 to 30 percent slopes	2,736	1,108	7.7
119	Trachute-Lava flows complex, very rarely flooded, 0 to 5 percent slopes	229	93	0.6
120	Tsosie very gravelly coarse sand, 1 to 5 percent slopes	311	126	0.9
121	Vitrandic Torriorthents, 10 to 63 percent slopes	92	37	0.3
	Total	35,460	14,361	100.0

Table 6.—Component, Map Unit Symbol, and Ecosite ID

(This report displays components and their associated map units and ecosite IDs. All components are major components)

Component name	Map unit symbol	Local phase	Component kind	Ecosite ID
Bighawk	100	none noted	series	R035XA108AZ
Bighawk family	101	tephra	family	R035XA108AZ
Cambidic Haplodurids	110	none noted	taxon above family	R035XB210AZ
Chedeski	102	tephra	series	R035XA108AZ
Flaco	103	tephra	series	R035XA108AZ
	104	tephra	series	R035XA108AZ
	105	tephra	series	R035XA113AZ
Gish	106	tephra	series	R035XA113AZ
Heiser	111	none noted	series	R035XB210AZ
	116	none noted	series	R035XB215AZ
Ives	107	none noted	series	R035XB209AZ
Meriwhitica	108	none noted	series	R035XA119AZ
Miburn	109	tephra	series	R035XB210AZ
	110	tephra	series	R035XB210AZ
	111	tephra	family	R035XB210AZ
Moenkopie	112	none noted	series	R035XB215AZ
	113	none noted	series	R035XB215AZ
Nalakihu	114	none noted	series	R035XB210AZ
Peshlaki	115	none noted	series	R035XA108AZ
Pocum	105	tephra	series	R035XA113AZ
Sandy, Typic Torriorthents	111	none noted	taxon above family	R035XB215AZ
Shinume	118	none noted	series	R035XB215AZ
Tsosie	120	tephra	series	R035XA113AZ
Trachute	119	tephra	series	R035XB231AZ
Typic Haplocambids	112	tephra	taxon above family	R035XB210AZ
Typic Torriorthents	116	none noted	taxon above family	R035XB215AZ
Vitrandic Torriorthents	121	none noted	taxon above family	R035XA102AZ

Table 7.—Ecological Site-Soil Correlation

(Only soils and miscellaneous land types with correlated ecological sites are shown)

Map unit symbol soil name and local phase, and percent of map unit	Ecological site name	Ecological site type	Ecological site ID
100:			
100%-Bighawk	Volcanic Upland 10-14″ p.z.	Rangeland	R035XA108AZ
101:			
85%-Bighawk family, tephra	Volcanic Upland 10-14″ p.z.	Rangeland	R035XA108AZ
102:			
90%-Chedeski, tephra	Volcanic Upland 10-14″ p.z.	Rangeland	R035XA108AZ
103:			
90%-Flaco, tephra	Volcanic Upland 10-14″ p.z.	Rangeland	R035XA108AZ
104:			
75%-Flaco, tephra	Volcanic Upland 10-14″ p.z.	Rangeland	R035XA108AZ
105:			
65%-Flaco, tephra	Loamy Upland 10-14″ p.z.	Rangeland	R035XA113AZ
25%-Pocum, tephra	Loamy Upland 10-14″ p.z.	Rangeland	R035XA113AZ
106:			
90%-Gish, tephra	Loamy Upland 10-14″ p.z.	Rangeland	R035XA113AZ
107:			
60%-Ives	Loamy Wash 6-10″ p.z.	Rangeland	R035XB209AZ
108:			
75%-Meriwhitica	Shallow Loamy 10-14″ p.z.	Rangeland	R035XA119AZ
109:			
85%-Miburn, tephra	Loamy Upland 6-10″ p.z.	Rangeland	R035XB210AZ
110:			
45%-Miburn, tephra	Loamy Upland 6-10″ p.z.	Rangeland	R035XB210AZ
40%-Cambidic Haplodurids	Loamy Upland 6-10″ p.z.	Rangeland	R035XB210AZ
111:			
50%-Miburn, tephra	Loamy Upland 6-10″ p.z.	Rangeland	R035XB210AZ
35%-Heiser	Loamy Upland 6-10″ p.z.	Rangeland	R035XB210AZ
112:			
45%-Moenkopie	Sandstone/Shale Upland 6-10″ p.z.	Rangeland	R035XB215AZ
40%-Typic Haplocambids, tephra	Loamy Upland 6-10″ p.z.	Rangeland	R035XB210AZ
113:			
70%-Moenkopie	Sandstone/Shale Upland 6-10″ p.z.	Rangeland	R035XB215AZ
114:			
85%-Nalakihu	Loamy Upland 6-10″ p.z.	Rangeland	R035XB210AZ
115:			
75%-Peshlaki	Volcanic Upland 10-14″ p.z.	Rangeland	R035XA108AZ

Table 7.—Ecological Site-Soil Correlation—Continued

Map unit symbol soil name and local phase, and percent of map unit	Ecological site name	Ecological site type	Ecological site ID
116:			
30%-Typic Torriorthents	Sandstone/Shale Upland 6-10″ p.z.	Rangeland	R035XB215AZ
25%-Heiser	Sandstone/Shale Upland 6-10″ p.z.	Rangeland	R035XB215AZ
117:			
100%-Sandy, Typic Torriorthents	Sandstone/Shale Upland 6-10″ p.z.	Rangeland	R035XB215AZ
118:			
85%-Shinume	Sandstone/Shale Upland 6-10″ p.z.	Rangeland	R035XB215AZ
119:			
80%-Trachute, tephra	Basalt Upland 6-10″ p.z.	Rangeland	R035XB231AZ
120:			
85%-Tsosie, tephra	Loamy Upland 10-14″ p.z.	Rangeland	R035XA113AZ
121:			
100%-Vitrandic Torriorthents	Cinder Hills 10-14″ p.z.	Rangeland	R035XA102AZ

Table 8.—Climate, Landscape, Landform, Parent Material, and Ecological Site

(Miscellaneous nonsoil components are not displayed in this report. Component percents may not add up to 100. MAP is the mean annual precipitation)

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	Ft	In				
100:								
Bighawk	100	1-5	5374-5722	10-14	Plateau	Alluvial fan	Alluvium derived from volcanic rock	Volcanic Upland 10-14" p.z., R035XA108AZ
101:								
Bighawk family, tephra	85	2-11	4757-5092	10-14	Basin	Alluvial fan	Tephra over residuum weathered from limestone	Volcanic Upland 10-14" p.z., R035XA108AZ
102:								
Chedeski, tephra	90	0-6	5282-5476	10-14	Plateau	Pediment	Cinders derived from volcanic rock over residuum weathered from sandstone and shale	Volcanic Upland 10-14" p.z., R035XA108AZ
103:								
Flaco, tephra	90	1-3	5246-5705	10-14	Plateau	Lava field	Residuum weathered from basalt	Volcanic Upland 10-14" p.z., R035XA108AZ
104:								
Flaco, tephra	75	1-18	4977-5712	10-14	Plateau	Lava field	Residuum weathered from basalt	Volcanic Upland 10-14" p.z., R035XA108AZ
105:								
Flaco, tephra	65	1-3	5266-5499	10-14	Plateau	Terrace	Alluvium derived from volcanic rock	Loamy Upland 10-14" p.z., R035XA113AZ
Pocum, tephra	25	1-3	5266-5499	10-14	Plateau	Terrace	Alluvium derived from volcanic rock over residuum weathered from limestone	Loamy Upland 10-14" p.z., R035XA113AZ
106:								
Gish, tephra	90	0-0	5341-5554	10-14	Plateau	Lakebed (relict)	Lacustrine deposits derived from igneous and sedimentary rock	Loamy Upland 10-14" p.z., R035XA113AZ

Table 8.—Climate, Landscape, Landform, Parent Material, and Ecological Site—Continued

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	Ft	In				
107:								
Ives	60	1-5	4288-4639	6-10	Basin	Channel	Alluvium derived from sedimentary rock	Loamy Wash 6-10″ p.z., R035XB209AZ
108:								
Meriwhitica	75	7-68	4488-5364	10-14	Plateau	Escarpment	Residuum weathered from limestone	Shallow Loamy 10-14″ p.z., R035XA119AZ
109:								
Miburn, tephra	85	0-10	4787-5039	6-10	Basin	Dune	Tephra derived from volcanic rock over alluvium derived from sedimentary rock	Loamy Upland 6-10″ p.z., R035XB210AZ
110:								
Miburn, tephra	45	1-8	4531-4888	6-10	Basin	Dune	Tephra derived from volcanic rock over alluvium derived from igneous and sedimentary rock	Loamy Upland 6-10″ p.z., R035XB210AZ
Cambidic Haplodurids	40	1-8	4531-4888	6-10	Basin	Terrace	Alluvium derived from igneous and sedimentary rock	Loamy Upland 6-10″ p.z., R035XB210AZ
111:								
Miburn, tephra	50	4-45	4560-5239	6-10	Basin	Climbing dune on escarpment	Tephra derived from volcanic rock over eolian sands derived from sedimentary rock	Loamy Upland 6-10″ p.z., R035XB210AZ
Heiser	35	4-45	4560-5239	6-10	Basin	Climbing dune on escarpment	Tephra derived from volcanic rock	Loamy Upland 6-10″ p.z., R035XB210AZ
112:								
Moenkopie	45	1-6	4393-4977	6-10	Basin	Structural bench	Residuum weathered from sandstone and shale	Sandstone/Shale Upland 6-10″ p.z., R035XB215AZ

Table 8.—Climate, Landscape, Landform, Parent Material, and Ecological Site—Continued

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	Ft	In				
112:								
Typic Halocambids, tephra	40	1-6	4393-4977	6-10	Basin	Structural bench	Residuum weathered from sandstone and shale	Loamy Upland 6-10″ p.z., R035XB210AZ
113:								
Moenkopie	70	1-14	4281-4951	6-10	Basin	Structural bench	Residuum weathered from mudstone and/or residuum weathered from sandstone	Sandstone/Shale Upland 6-10″ p.z., R035XB215AZ
114:								
Nalakihu	85	0-4	4662-4813	6-10	Plateau	Lava field	Residuum weathered from basalt	Loamy Upland 6-10″ p.z., R035XB210AZ
115:								
Peshlaki	75	1-11	4505-5528	10-14	Plateau	Structural bench	Cinders derived from volcanic rock over residuum weathered from limestone	Volcanic Upland 10-14″ p.z., R035XA108AZ
116:								
Typic Torriorthents	30	3-40	4340-4961	6-10	Basin	Escarpment	Residuum weathered from sandstone and shale	Sandstone/Shale Upland 6-10″ p.z., R035XB215AZ
Heiser	25	3-40	4340-4961	6-10	Basin	Escarpment	Tephra derived from volcanic rock	Sandstone/Shale Upland 6-10″ p.z., R035XB215AZ
117:								
Sandy, Typic Torriorthents	100	1-15	4423-4547	6-10	Basin	Cuesta and dip slopes	Residuum weathered from conglomerate, residuum weathered from arkose, and/or residuum weathered from sandstone	Sandstone/Shale Upland 6-10″ p.z., R035XB215AZ
118:								
Shinume	85	2-30	4281-4905	6-10	Basin	Cuesta and escarpment	Residuum weathered from sandstone and shale	Sandstone/Shale Upland 6-10″ p.z., R035XB215AZ

Table 8.—Climate, Landscape, Landform, Parent Material, and Ecological Site—Continued

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	Ft	In				
119:								
Trachute, tephra---	80	0-5	4285-4340	6-10	Basin	Terrace	Alluvium derived from volcanic and sedimentary rock	Basalt Upland 6-10" p.z., R035XB231AZ
120:								
Tsosie, tephra-----	85	1-5	5282-5476	10-14	Plateau	Valley floor	Cinders derived from volcanic rock over alluvium derived from sedimentary rock	Loamy Upland 10-14" p.z., R035XA113AZ
121:								
Vitrandic Torriorthents-----	100	10-63	5026-5590	10-14	Basin	Cinder cone	Tephra derived from volcanic rock	Cinder Hills 10-14" p.z., R035XA102AZ

Table 9.—Canopy Cover

(This report gives the canopy cover for the plant species associated with the map unit soil components. Only soils and miscellaneous land types with correlated ecological sites are shown. Canopy cover is determined by crown perimeter-vertical projection by species. This cover can overlap in layers by species so total cover can be greater than 100 percent. Plants listed with no percent canopy cover are less than one percent cover)

Map unit symbol, soil name, and local phase and percent of map unit	Ecological site	Characteristic vegetation	Canopy cover
			Pct
100:			
Bighawk - 100%----	Volcanic Upland 10-14” p.z. (R035XA108AZ)	James’ galleta	28
		Needle and thread	12
		Rubber rabbitbrush	10
		Black grama	8
101:			
Bighawk family, tephra – 85%-----	Volcanic Upland 10-14” p.z. (R035XA108AZ)	Black grama	24
		Rubber rabbitbrush	14
		James’ galleta	4
		Cutler’s jointfir	2
102:			
Chedeski, tephra – 90%-----	Volcanic Upland 10-14” p.z. (R035XA108AZ)	James’ galleta	10
		Indian ricegrass	2
		Black grama	2
103:			
Flaco, tephra - 90%--------------	Volcanic Upland 10-14” p.z. (R035XA108AZ)	James’ galleta	44
		Russian thistle	16
		Oneseed juniper	6
104:			
Flaco, tephra - 75%--------------	Volcanic Upland 10-14” p.z. (R035XA108AZ)	James’ galleta	34
		Oneseed Juniper	16
105:			
Flaco, tephra - 65%--------------	Loamy Upland 10-14” p.z. (R035XA113AZ)	James’ galleta	54
		Rubber rabbitbrush	4
		Needle and thread	2
Pocum, tephra - 25%--------------	Loamy Upland 10-14” p.z. (R035XA113AZ)	James’ galleta	54
		Rubber rabbitbrush	4
		Needle and thread	2
106:			
Gish, tephra - 90%--------------	Loamy Upland 10-14” p.z. (R035XA113AZ)	James’ galleta	44
		Alkali sacaton	12
		Perennial forbs	4
107:			
Ives - 60%--------	Loamy Wash 6-10” p.z. (R035XB209AZ)	Fourwing saltbush	10

Table 9.—Canopy Cover—Continued

Map unit symbol, soil name, and local phase and percent of map unit	Ecological site	Characteristic vegetation	Canopy cover
			Pct
108:			
Meriwhitica - 75%	Shallow Loamy 10-14″ p.z. (R035XA119AZ)	Black grama	6
		Shadscale saltbush	4
		Hogpotato	4
		Spike dropseed	4
		Oneseed juniper	2
		Threeawn	2
		Wolfstail	2
109:			
Miburn, tephra - 85%-----	Loamy Upland 6-10″ p.z. (R035XB210AZ)	Buckwheat	12
		Narrowleaf yucca	4
110:			
Miburn, tephra - 45%-----	Loamy Upland 6-10″ p.z. (R035XB210AZ)	James' galleta	24
		Rubber rabbitbrush	6
Cambidic Halodurids - 40%	Loamy Upland 6-10″ p.z. (R035XB210AZ)	James' galleta	24
		Rubber rabbitbrush	6
111:			
Miburn, tephra - 50%-----	Loamy Upland 6-10″ p.z. (R035XB210AZ)	Rubber rabbitbrush	10
		Buckwheat	4
Heiser - 35%------	Loamy Upland 6-10″ p.z. (R035XB210AZ)	Rubber rabbitbrush	10
		Buckwheat	4
112:			
Moenkopie - 45%---	Sandstone/Shale Upland 6-10″ p.z. (R035XB215AZ)	Fourwing saltbush	16
		Torrey's jointfir	12
		Globemallow	2
Typic Haplocambids, tephra - 40%-----	Loamy Upland 6-10″ p.z. (R035XB210AZ)	Fourwing saltbush	16
		Torrey's jointfir	12
		Globemallow	2
113:			
Moenkopie - 70%---	Sandstone/Shale Upland 6-10″ p.z. (R035XB215AZ)	Torrey's jointfir	4
114:			
Nalakihu - 85%----	Loamy Upland 6-10″ p.z. (R035XB210AZ)	James' galleta	32
		Rubber rabbitbrush	4
		Bush muhly	2
		Torrey's jointfir	2
115:			
Peshlaki - 75%----	Volcanic Upland 10-14″ p.z. (R035XA108AZ)	Black grama	12
		James' galleta	10

Table 9.—Canopy Cover—Continued

Map unit symbol, soil name, and local phase and percent of map unit	Ecological site	Characteristic vegetation	Canopy cover
			Pct
116:			
Typic Torriorthents - 30%	Sandstone/Shale Upland 6-10″ p.z. (R035XB215AZ)	Apache plume	16
		Black grama	2
		Cutler's jointfir	2
		Fourwing saltbush	2
		James' galleta	2
		Rubber rabbitbrush	2
		Sand sagebrush	2
Heiser - 25%	Sandstone/Shale Upland 6-10″ p.z. (R035XB215AZ)	Apache plume	16
		Black grama	2
		Cutler's jointfir	2
		Fourwing saltbush	2
		James' galleta	2
		Rubber rabbitbrush	2
		Sand sagebrush	2
117:			
Sandy, Typic Torriorthents - 100%	Sandstone/Shale Upland 6-10″ p.z. (R035XB215AZ)	Indian ricegrass	6
		Mesa dropseed	2
		Rubber rabbitbrush	2
		Torrey's jointfir	2
118:			
Shinume - 85%	Sandstone/Shale Upland 6-10″ p.z. (R035XB215AZ)	James' galleta	16
		Indian ricegrass	4
		Torrey's jointfir	2
119:			
Trachute, tephra - 80%	Basalt Upland 6-10″ p.z. (R035XB231AZ)	Alkali sacaton	8
		Shadscale saltbush	4
		James' galleta	2
120:			
Tsosie, tephra - 85%	Loamy Upland 10-14″ p.z. (R035XA113AZ)	James' galleta	50
		Fourwing saltbush	16
121:			
Vitrandic Torriorthents - 100%	Cinder Hills 10-14″ p.z. (R035XA102AZ)	Apache plume	4

Table 10.—Index of Common and Scientific Plant Names and Plant Symbols
Sorted by Common Name

(Plants displayed occur within the National Soils Information System (NASIS) plant tables used for the soil survey area. The scientific and common names are referenced at the USDA PLANTS database: plants.usda.gov)

Local common name	Scientific name	Plant symbol
alkali sacaton	Sporobolus airoides	SPAI
Apache plume	Fallugia	FALLU
Apache plume	Fallugia paradoxa	FAPA
Bigelow sage	Artemisia bigelovii	ARBI3
black grama	Bouteloua eriopoda	BOER4
blue grama	Bouteloua gracilis	BOGR2
broom snakeweed	Gutierrezia sarothrae	GUSA2
buckwheat	Eriogonum	ERIOG
bush muhly	Muhlenbergia porteri	MUPO2
Cutler's jointfir	Ephedra cutleri	EPCU
dropseed	Sporobolus	SPORO
fleabane	Erigeron	ERIGE2
fluffgrass	Dasyochloa pulchella	DAPU7
Forb, annual		2FA
four o'clock	Mirabilis	MIRAB
fourwing saltbush	Atriplex canescens	ATCA2
galleta	Pleuraphis jamesii	PLJA
globemallow	Sphaeralcea	SPHAE
Indian ricegrass	Achnatherum hymenoides	ACHY
James' galleta	Pleuraphis jamesii	PLJA
lambert crazyweed	Oxytropis lambertii	OXLA3
mesa dropseed	Sporobolus flexuosus	SPFL2
milkweed	Asclepias	ASCLE
narrowleaf stoneseed	Lithospermum incisum	LIIN2
narrowleaf yucca	Yucca angustissima	YUAN2
needle and thread	Hesperostipa comata	HECO26
oneseed juniper	Juniperus monosperma	JUMO
Phacelia	Phacelia	PHACE
primrose	Oenothera	OENOT
Rocky Mountain zinnia	Zinnia grandiflora	ZIGR
rosemary mint	Poliomintha incana	POIN3
rubber rabbitbrush	Ericameria nauseosus	CHNA2
Russian thistle	Salsola	SALSO
Russian-thistle	Salsola kali	SAKA
sand bluestem	Andropogon hallii	ANHA
sand sagebrush	Artemisia filifolia	ARFI2
shadscale	Atriplex confertifolia	ATCO
sideoats grama	Bouteloua curtipendula	BOCU
sumac	Rhus	RHUS
threeawn	Aristida	ARIST
Torrey's jointfir	Ephedra torreyana	EPTO
wolfberry	Lycium	LYCIU
woody crinklemat	Tiquilia canescens	TICA3

Table 11.—Index of Common and Scientific Plant Names and Plant Symbols
Sorted by Scientific Name

(Plants displayed occur within the National Soils Information System (NASIS) plant tables used for the soil survey area. The scientific and common names are referenced at the USDA PLANTS database: plants.usda.gov)

Local common name	Scientific name	Plant symbol
Forb, annual		2FA
Indian ricegrass	Achnatherum hymenoides	ACHY
sand bluestem	Andropogon hallii	ANHA
Bigelow sage	Artemisia bigelovii	ARBI3
sand sagebrush	Artemisia filifolia	ARFI2
threeawn	Aristida	ARIST
milkweed	Asclepias	ASCLE
fourwing saltbush	Atriplex canescens	ATCA2
shadscale	Atriplex confertifolia	ATCO
sideoats grama	Bouteloua curtipendula	BOCU
black grama	Bouteloua eriopoda	BOER4
blue grama	Bouteloua gracilis	BOGR2
fluffgrass	Dasyochloa pulchella	DAPU7
Cutler’s jointfir	Ephedra cutleri	EPCU
Torrey’s jointfir	Ephedra torreyana	EPTO
rubber rabbitbrush	Ericameria nauseosus	CHNA2
fleabane	Erigeron	ERIGE2
buckwheat	Eriogonum	ERIOG
Apache plume	Fallugia	FALLU
Apache plume	Fallugia paradoxa	FAPA
broom snakeweed	Gutierrezia sarothrae	GUSA2
needle and thread	Hesperostipa comata	HECO26
oneseed juniper	Juniperus monosperma	JUMO
narrowleaf stoneseed	Lithospermum incisum	LIIN2
wolfberry	Lycium	LYCIU
four o’clock	Mirabilis	MIRAB
bush muhly	Muhlenbergia porteri	MUPO2
primrose	Oenothera	OENOT
lambert crazyweed	Oxytropis lambertii	OXLA3
Phacelia	Phacelia	PHACE
galleta	Pleuraphis jamesii	PLJA
James’ galleta	Pleuraphis jamesii	PLJA
rosemary mint	Poliomintha incana	POIN3
sumac	Rhus	RHUS
Russian-thistle	Salsola kali	SAKA
Russian thistle	Salsola	SALSO
alkali sacaton	Sporobolus airoide	SPAI
mesa dropseed	Sporobolus flexuos	SPFL2
globemallow	Sphaeralcea	SPHAE
dropseed	Sporobolus	SPORO
woody crinklemat	Tiquilia canescens	TICA3
narrowleaf yucca	Yucca angustissima	YUAN2
Rocky Mountain zinnia	Zinnia grandiflora	ZIGR

Table 12.—Rangeland Ecological Sites and Characteristic Plant Communities

(Range site composition is based on percent dry weight. Absence of an entry indicates the species totaled is less than one percent of annual production. Only soils and miscellaneous land types with correlated ecological sites are shown)

Map symbol and soil name	Ecological site name and number	Total production: Kind of year	Total production: Dry weight	Existing vegetation	Composition
			Lb/ac		Pct
100:					
Bighawk	Volcanic Upland 10-14″ p.z.	Favorable	75	galleta	30
	(R035XA108AZ)	Normal	100	black grama	25
		Unfavorable	800	needle and thread	25
				rubber rabbitbrush	10
				Russian thistle	5
				Forb, annual	3
				Rocky Mountain zinnia	2
101:					
Bighawk family	Volcanic Upland 10-14″ p.z.	Favorable	75	black grama	20
	(R035XA108AZ)	Normal	100	bush muhly	15
		Unfavorable	800	oneseed juniper	15
				Cutler’s jointfir	10
				galleta	10
				rubber rabbitbrush	10
				sand sagebrush	10
				wolfberry	10
				Apache plume	0
				fourwing saltbush	0
102:					
Chedeski	Volcanic Upland 10-14″ p.z.	Favorable	75	galleta	50
	(R035XA108AZ)	Normal	100	oneseed juniper	40
		Unfavorable	800	black grama	10
				Indian ricegrass	0
				needle and thread	0
				threeawn	0
103:					
Flaco	Volcanic Upland 10-14″ p.z.	Favorable	75	galleta	30
	(R035XA108AZ)	Normal	100	Russian-thistle	30
		Unfavorable	800	black grama	20
				needle and thread	10
				oneseed juniper	10
104:					
Flaco	Volcanic Upland 10-14″ p.z.	Favorable	75	galleta	45
	(R035XA108AZ)	Normal	100	oneseed juniper	20
		Unfavorable	800	alkali sacaton	10
				black grama	10
				Apache plume	5
				sideoats grama	5
				milkweed	3
				four o’clock	2
105:					
Flaco	Loamy Upland 10-14″ p.z.	Favorable	460	galleta	60
	(R035XA113AZ)	Normal	610	needle and thread	20
		Unfavorable	750	rubber rabbitbrush	10
				alkali sacaton	5
				oneseed juniper	5
				black grama	0

Table 12.—Rangeland Ecological Sites and Characteristic Plant Communities—Continued

Map symbol and soil name	Ecological site name and number	Total production: Kind of year	Total production: Dry weight	Existing vegetation	Composition
			Lb/ac		Pct
105:					
Pocum	Loamy Upland 10-14″ p.z.	Favorable	460	galleta	50
	(R035XA113AZ)	Normal	610	needle and thread	20
		Unfavorable	750	alkali sacaton	10
				black grama	10
				oneseed juniper	5
				rubber rabbitbrush	5
106:					
Gish	Loamy Upland 10-14″ p.z.	Favorable	460	galleta	60
	(R035XA113AZ)	Normal	610	alkali sacaton	20
		Unfavorable	750	Forb, annual	10
				rubber rabbitbrush	10
107:					
Ives	Loamy Wash 6-10″ p.z.	Favorable	800	fourwing saltbush	80
	(R035XB209AZ)	Normal	1200	alkali sacaton	20
		Unfavorable	1600		
108:					
Meriwhitica	Shallow Loamy 10-14″ p.z.	Favorable	500	black grama	30
	(R035XA119AZ)	Normal	650	Cutler’s jointfir	20
		Unfavorable	800	needle and thread	20
				shadscale	20
				alkali sacaton	6
				oneseed juniper	2
				rubber rabbitbrush	2
				Bigelow sage	0
109:					
Miburn	Loamy Upland 6-10″ p.z.	Favorable	350	Torrey’s jointfir	30
	(R035XB210AZ)	Normal	550	buckwheat	20
		Unfavorable	700	Indian ricegrass	10
				narrowleaf yucca	10
				Apache plume	5
				needle and thread	5
				sand bluestem	0
110:					
Miburn	Loamy Upland 6-10″ p.z.	Favorable	350	galleta	60
	(R035XB210AZ)	Normal	550	rubber rabbitbrush	20
		Unfavorable	700	Forb, annual	5
				globemallow	5
				Indian ricegrass	5
				oneseed juniper	5
Cambidic Haplodurids	Loamy Upland 6-10″ p.z.	Favorable	350	galleta	40
	(R035XB210AZ)	Normal	550	black grama	20
		Unfavorable	700	rubber rabbitbrush	10
				Apache plume	5
				globemallow	5
				Indian ricegrass	5
				oneseed juniper	5
				Phacelia	5
				Torrey’s jointfir	5
				fleabane	0

Table 12.—Rangeland Ecological Sites and Characteristic Plant Communities—Continued

Map symbol and soil name	Ecological site name and number	Total production: Kind of year	Total production: Dry weight	Existing vegetation	Composition
			Lb/ac		Pct
111:					
Miburn	Loamy Upland 6-10" p.z. (R035XB210AZ)	Favorable	350	buckwheat	30
		Normal	550	rubber rabbitbrush	20
		Unfavorable	700	Torrey's jointfir	20
				sand sagebrush	10
				Indian ricegrass	5
				James' galleta	5
				oneseed juniper	5
				threeawn	5
Heiser	Loamy Upland 6-10" p.z. (R035XB210AZ)	Favorable	350	rubber rabbitbrush	40
		Normal	550	buckwheat	30
		Unfavorable	700	Indian ricegrass	15
				Torrey's jointfir	10
				threeawn	5
112:					
Moenkopie	Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ)	Favorable	250	Torrey's jointfir	40
		Normal	350	fourwing saltbush	20
		Unfavorable	485	bush muhly	15
				broom snakeweed	5
				fluffgrass	5
				globemallow	5
Typic Haplocambids	Loamy Upland 6-10" p.z. (R035XB210AZ)	Favorable	350	Torrey's jointfir	40
		Normal	550	fourwing saltbush	30
		Unfavorable	700	broom snakeweed	10
				rubber rabbitbrush	8
				bush muhly	5
				sand sagebrush	5
				globemallow	2
				Indian ricegrass	0
113:					
Moenkopie	Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ)	Favorable	250	Torrey's jointfir	50
		Normal	350	James' galleta	15
		Unfavorable	485	fluffgrass	5
				globemallow	5
				broom snakeweed	0
				fourwing saltbush	0
114:					
Nalakihu	Loamy Upland 6-10" p.z. (R035XB210AZ)	Favorable	350	James' galleta	45
		Normal	550	alkali sacaton	20
		Unfavorable	700	rubber rabbitbrush	20
				Torrey's jointfir	10
				dropseed	5
				fourwing saltbush	0
115:					
Peshlaki	Volcanic Upland 10-14" p.z. (R035XA108AZ)	Favorable	75	black grama	40
		Normal	100	oneseed juniper	35
		Unfavorable	800	James' galleta	20
				lambert crazyweed	5
				Indian ricegrass	0

Table 12.—Rangeland Ecological Sites and Characteristic Plant Communities—Continued

Map symbol and soil name	Ecological site name and number	Total production: Kind of year	Total production: Dry weight	Existing vegetation	Composition
			Lb/ac		Pct
116:					
Typic Torriorthents	Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ)	Favorable	250	Apache plume	50
		Normal	350	fourwing saltbush	20
		Unfavorable	485	bush muhly	15
				Cutler's jointfir	10
				broom snakeweed	5
				Phacelia	0
				sand sagebrush	0
				sumac	0
Heiser	Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ)	Favorable	250	Apache plume	50
		Normal	350	fourwing saltbush	20
		Unfavorable	485	bush muhly	15
				Cutler's jointfir	10
				broom snakeweed	5
				Phacelia	0
				sand sagebrush	0
				sumac	0
117:					
Sandy, Typic Torriorthents	Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ)	Favorable	250	Torrey's jointfir	25
		Normal	350	mesa dropseed	15
		Unfavorable	485	Indian ricegrass	10
				James' galleta	10
				buckwheat	5
				Forb, annual	5
				narrowleaf stoneseed	5
				narrowleaf yucca	5
				rosemary mint	5
				sand sagebrush	5
				woody crinklemat	5
				globemallow	3
				primrose	2
118:					
Shinume	Sandstone/Shale Upland 6-10" p.z. (R035XB215AZ)	Favorable	250	Torrey's jointfir	40
		Normal	350	James' galleta	30
		Unfavorable	485	fourwing saltbush	20
				fluffgrass	5
				Indian ricegrass	5
119:					
Trachute	Basalt Upland 6-10" p.z. (R035XB231AZ)	Favorable	80	alkali sacaton	40
		Normal	230	shadscale	25
		Unfavorable	390	galleta	20
				fourwing saltbush	10
				Forb, annual	5
				broom snakeweed	0
				Torrey's jointfir	0
120:					
Tsosie	Loamy Upland 10-14" p.z. (R035XA113AZ)	Favorable	460	galleta	95
		Normal	610	fourwing saltbush	5
		Unfavorable	750		

Table 12.—Rangeland Ecological Sites and Characteristic Plant Communities—Continued

Map symbol and soil name	Ecological site name and number	Total production: Kind of year	Total production: Dry weight	Existing vegetation	Composition
			Lb/ac		Pct
121:					
Vitrandic Torriorthents-	Cinder Hills 10-14” p.z. (R035XA102AZ)	Favorable	0	Apache plume	80
		Normal	56	buckwheat	15
		Unfavorable	80	Cutler’s jointfir	5

Table 13.—Land Capability Classification

(Land capability classification is a system of grouping soils primarily on the basis of their capability to produce common cultivated crops and pasture plants without deteriorating over a long period of time. Only the soils suitable for cultivation are listed. The classification is for nonirrigated areas)

Map unit symbol and component name	Land capability
100:	
Bighawk	6c
101:	
Bighawk family, tephra	6c
102:	
Chedeski, tephra	6c
103:	
Flaco, tephra	6c
104:	
Flaco, tephra	6c
105:	
Flaco, tephra	6c
Pocum, tephra	6c
106:	
Gish, tephra	5c
107:	
Ives	7c
108:	
Meriwhitica	6c
109:	
Miburn, tephra	7c
110:	
Miburn, tephra	7c
Cambidic Haplodurids	7c
111:	
Miburn, tephra	7c
Heiser	7c
112:	
Moenkopie	7c
Typic Haplocambids, tephra	7c
113:	
Moenkopie	7c
114:	
Nalakihu	7c
115:	
Peshlaki	6c

Table 13.—Land Capability Classification—Continued

Map unit symbol and component name	Land capability
116:	
Typic Torriorthents	7c
Heiser	7c
117:	
Sandy, Typic Torriorthents	7c
118:	
Shinume	7c
119:	
Trachute, tephra	7c
120:	
Tsosie, tephra	6c
121:	
Vitrandic Torriorthents	6c

Table 14.—Land Management, Part I (Planting)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Suitability for hand planting: Rating class and limiting features	Value	Suitability for mechanical planting: Rating class and limiting features	Value	Suitability for use of harvesting equipment: Rating class and limiting features	Value
100:							
Bighawk	100	Moderately suited		Poorly suited		Moderate	
		Rock fragments	0.50	Rock fragments	0.75	Low strength	0.50
101:							
Bighawk family, tephra	85	Moderately suited		Poorly suited		Moderate	
		Rock fragments	0.50	Rock fragments	0.75	Low strength	0.50
102:							
Chedeski, tephra	90	Moderately suited		Poorly suited		Moderate	
		Rock fragments	0.50	Rock fragments	0.75	Low strength	0.50
103:							
Flaco, tephra	90	Moderately suited		Poorly suited		Moderate	
		Stickiness; high plasticity index	0.50	Rock fragments	0.75	Low strength	0.50
		Rock fragments	0.50	Stickiness; high plasticity index	0.50		
104:							
Flaco, tephra	75	Moderately suited		Poorly suited		Moderate	
		Stickiness; high plasticity index	0.50	Rock fragments	0.75	Low strength	0.50
		Rock fragments	0.50	Stickiness; high plasticity index	0.50		
Lava flows, basalt	10	Not rated		Not rated		Not rated	
105:							
Flaco, tephra	65	Moderately suited		Poorly suited		Moderate	
		Stickiness; high plasticity index	0.50	Rock fragments	0.75	Low strength	0.50
		Rock fragments	0.50	Stickiness; high plasticity index	0.50		
Pocum, tephra	25	Well suited		Moderately suited		Moderate	
				Rock fragments	0.50	Low strength	0.50
106:							
Gish, tephra	90	Moderately suited		Poorly suited		Moderate	
		Stickiness; high plasticity index	0.50	Rock fragments	0.75	Low strength	0.50
		Rock fragments	0.50	Stickiness; high plasticity index	0.50		
107:							
Ives	60	Well suited		Moderately suited		Moderate	
				Rock fragments	0.50	Low strength	0.50
Riverwash	20	Not rated		Not rated		Not rated	

Table 14.—Land Management, Part I (Planting)—Continued

Map unit symbol and soil name	Pct. of map unit	Suitability for hand planting: Rating class and limiting features	Value	Suitability for mechanical planting: Rating class and limiting features	Value	Suitability for use of harvesting equipment: Rating class and limiting features	Value
108:							
Meriwhitica-----	75	Unsuited		Unsuited		Moderate	
		Restrictive layer	1.00	Rock fragments	1.00	Low strength	0.50
		Rock fragments	0.75	Slope	1.00		
				Restrictive layer	1.00		
Rock outcrop, limestone------	25	Not rated		Not rated		Not rated	
109:							
Miburn, tephra--	85	Well suited		Moderately suited		Moderate	
				Rock fragments	0.50	Low strength	0.50
110:							
Miburn, tephra--	45	Moderately suited		Moderately suited		Moderate	
		Sandiness	0.50	Sandiness	0.50	Low strength	0.50
				Slope	0.50		
				Rock fragments	0.50		
Cambidic Haplodurids----	40	Well suited		Moderately suited		Moderate	
				Slope	0.50	Low strength	0.50
111:							
Miburn, tephra--	50	Well suited		Poorly suited		Moderate	
				Slope	0.75	Low strength	0.50
				Rock fragments	0.50		
Heiser----------	35	Moderately suited		Moderately suited		Moderate	
		Sandiness	0.50	Slope	0.50	Low strength	0.50
				Sandiness	0.50		
				Rock fragments	0.50		
Lava flows, basalt---------	10	Not rated		Not rated		Not rated	
112:							
Moenkopie-------	45	Unsuited		Unsuited		Moderate	
		Restrictive layer	1.00	Restrictive layer	1.00	Low strength	0.50
		Rock fragments	0.50	Rock fragments	0.75		
Typic Haplocambids, tephra---------	40	Well suited		Moderately suited		Moderate	
				Rock fragments	0.50	Low strength	0.50
113:							
Moenkopie-------	70	Moderately suited		Poorly suited		Moderate	
		Rock fragments	0.50	Rock fragments	0.75	Low strength	0.50
Rock outcrop, sandstone------	20	Not rated		Not rated		Not rated	
114:							
Nalakihu--------	85	Well suited		Moderately suited		Moderate	
				Rock fragments	0.50	Low strength	0.50

Table 14.—Land Management, Part I (Planting)—Continued

Map unit symbol and soil name	Pct. of map unit	Suitability for hand planting: Rating class and limiting features	Value	Suitability for mechanical planting: Rating class and limiting features	Value	Suitability for use of harvesting equipment: Rating class and limiting features	Value
115:							
Peshlaki--------	75	Unsuited		Unsuited		Moderate	
		Restrictive layer	1.00	Rock fragments	1.00	Low strength	0.50
		Rock fragments	0.50	Restrictive layer	1.00		
		Sandiness	0.50	Sandiness	0.50		
Rock outcrop, limestone------	10	Not rated		Not rated		Not rated	
116:							
Rock outcrop, sandstone------	35	Not rated		Not rated		Not rated	
Typic Torriorthents--	30	Poorly suited		Unsuited		Moderate	
		Rock fragments	0.75	Rock fragments	1.00	Low strength	0.50
				Slope	0.75		
Heiser----------	25	Moderately suited		Poorly suited		Moderate	
		Sandiness	0.50	Slope	0.75	Low strength	0.50
				Rock fragments	0.50		
				Sandiness	0.50		
117:							
Sandy, Typic Torriorthents--	100	Moderately suited		Moderately suited		Moderate	
		Sandiness	0.50	Rock fragments	0.50	Low strength	0.50
				Sandiness	0.50		
118:							
Shinume---------	85	Moderately suited		Poorly suited		Moderate	
		Rock fragments	0.50	Slope	0.75	Low strength	0.50
				Rock fragments	0.75		
119:							
Trachute, tephra	80	Moderately suited		Poorly suited		Moderate	
		Rock fragments	0.50	Rock fragments	0.75	Low strength	0.50
Lava flows, basalt---------	10	Not rated		Not rated		Not rated	
120:							
Tsosie, tephra--	85	Moderately suited		Poorly suited		Moderate	
		Stickiness; high plasticity index	0.50	Rock fragments	0.75	Low strength	0.50
		Rock fragments	0.50	Stickiness; high plasticity index	0.50		
121:							
Vitrandic Torriorthents--	100	Moderately suited		Unsuited		Moderate	
		Rock fragments	0.50	Slope	1.00	Low strength	0.50
		Sandiness	0.50	Rock fragments	0.75		
				Sandiness	0.50		

Table 14.—Land Management, Part II (Hazard of Erosion and Suitability for Roads)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Hazard of erosion: Rating class and limiting features	Value	Hazard of erosion on roads and trails: Rating class and limiting features	Value	Suitability for roads (natural surface): Rating class and limiting features	Value
100:							
Bighawk	100	Slight		Slight		Well suited	
						Dusty	0.05
101:							
Bighawk family, tephra	85	Slight		Slight		Moderately suited	
						Sandiness	0.50
102:							
Chedeski, tephra	90	Slight		Slight		Well suited	
						Dusty	0.14
103:							
Flaco, tephra	90	Slight		Slight		Well suited	
						Dusty	0.13
104:							
Flaco, tephra	75	Slight		Slight		Well suited	
						Dusty	0.20
Lava flows, basalt	10	Not rated		Not rated		Not rated	
105:							
Flaco, tephra	65	Slight		Slight		Well suited	
						Dusty	0.10
Pocum, tephra	25	Slight		Slight		Well suited	
						Dusty	0.08
106:							
Gish, tephra	90	Slight		Slight		Well suited	
						Dusty	0.16
107:							
Ives	60	Slight		Slight		Well suited	
						Dusty	0.01
Riverwash	20	Not rated		Not rated		Not rated	
108:							
Meriwhitica	75	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Rock fragments	0.50
Rock outcrop, limestone	25	Not rated		Not rated		Not rated	
109:							
Miburn, tephra	85	Slight		Slight		Moderately suited	
						Sandiness	0.50

Table 14.—Land Management, Part II (Hazard of Erosion and Suitability for Roads)—Continued

Map unit symbol and soil name	Pct. of map unit	Hazard of erosion: Rating class and limiting features	Value	Hazard of erosion on roads and trails: Rating class and limiting features	Value	Suitability for roads (natural surface): Rating class and limiting features	Value
110:							
Miburn, tephra	45	Slight		Slight		Moderately suited	
						Sandiness	0.50
						Slope	0.50
Cambidic Haplodurids	40	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Slope	0.50
111:							
Miburn, tephra	50	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Sandiness	0.50
Heiser	35	Moderate		Moderate		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.50	Slope	1.00
						Sandiness	0.50
Lava flows, basalt	10	Not rated		Not rated		Not rated	
112:							
Moenkopie	45	Slight		Slight		Well suited	
						Dusty	0.13
Typic Haplocambids, tephra	40	Slight		Slight		Well suited	
113:							
Moenkopie	70	Slight		Slight		Moderately suited	
						Rock fragments	0.50
Rock outcrop, sandstone	20	Not rated		Not rated		Not rated	
114:							
Nalakihu	85	Slight		Slight		Well suited	
						Dusty	0.03
115:							
Peshlaki	75	Slight		Slight		Moderately suited	
						Sandiness	0.50
Rock outcrop, limestone	10	Not rated		Not rated		Not rated	
116:							
Rock outcrop, sandstone	35	Not rated		Not rated		Not rated	
Typic Torriorthents	30	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Rock fragments	0.50
						Dusty	0.24
Heiser	25	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Sandiness	0.50

Table 14.—Land Management, Part II (Hazard of Erosion and Suitability for Roads)—Continued

Map unit symbol and soil name	Pct. of map unit	Hazard of erosion		Hazard of erosion on roads and trails		Suitability for roads (natural surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
117:							
Sandy, Typic Torriorthents--	100	Slight		Slight		Well suited	
118:							
Shinume---------	85	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Dusty	0.02
119:							
Trachute, tephra	80	Slight		Slight		Well suited	
						Dusty	0.01
Lava flows, basalt---------	10	Not rated		Not rated		Not rated	
120:							
Tsosie, tephra--	85	Slight		Slight		Well suited	
						Dusty	0.26
121:							
Vitrandic Torriorthents--	100	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Sandiness	0.50

Table 14.—Land Management, Part III (Site Preparation)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Suitability for mechanical site preparation (deep)		Suitability for mechanical site preparation (surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value
100:					
Bighawk	100	Well suited		Poorly suited	
				Rock fragments	0.50
101:					
Bighawk family, tephra	85	Well suited		Poorly suited	
				Rock fragments	0.50
102:					
Chedeski, tephra	90	Poorly suited		Poorly suited	
		Restrictive layer	0.50	Rock fragments	0.50
103:					
Flaco, tephra	90	Poorly suited		Poorly suited	
		Restrictive layer	0.50	Rock fragments	0.50
104:					
Flaco, tephra	75	Poorly suited		Poorly suited	
		Restrictive layer	0.50	Rock fragments	0.50
Lava flows, basalt	10	Not rated		Not rated	
105:					
Flaco, tephra	65	Unsuited		Well suited	
		Restrictive layer	1.00		
Pocum, tephra	25	Poorly suited		Well suited	
		Restrictive layer	0.50		
106:					
Gish, tephra	90	Well suited		Poorly suited	
				Rock fragments	0.50
107:					
Ives	60	Well suited		Well suited	
Riverwash	20	Not rated		Not rated	
108:					
Meriwhitica	75	Unsuited		Unsuited	
		Restrictive layer	1.00	Restrictive layer	1.00
		Rock fragments	0.50	Rock fragments	0.50
		Slope	0.50	Slope	0.50
Rock outcrop, limestone	25	Not rated		Not rated	
109:					
Miburn, tephra	85	Well suited		Well suited	

Table 14.—Land Management, Part III (Site Preparation)—Continued

Map unit symbol and soil name	Pct. of map unit	Suitability for mechanical site preparation (deep): Rating class and limiting features	Value	Suitability for mechanical site preparation (surface): Rating class and limiting features	Value
110:					
Miburn, tephra------	45	Well suited		Well suited	
Cambidic Haplodurids	40	Well suited		Well suited	
111:					
Miburn, tephra------	50	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
		Restrictive layer	0.50		
Heiser--------------	35	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
Lava flows, basalt--	10	Not rated		Not rated	
112:					
Moenkopie-----------	45	Unsuited		Unsuited	
		Restrictive layer	1.00	Restrictive layer	1.00
Typic Haplocambids, tephra-------------	40	Well suited		Well suited	
113:					
Moenkopie-----------	70	Unsuited		Poorly suited	
		Restrictive layer	1.00	Rock fragments	0.50
Rock outcrop, sandstone----------	20	Not rated		Not rated	
114:					
Nalakihu------------	85	Poorly suited		Well suited	
		Restrictive layer	0.50		
115:					
Peshlaki------------	75	Unsuited		Unsuited	
		Restrictive layer	1.00	Restrictive layer	1.00
				Rock fragments	0.50
Rock outcrop, limestone----------	10	Not rated		Not rated	
116:					
Rock outcrop, sandstone----------	35	Not rated		Not rated	
Typic Torriorthents-	30	Poorly suited		Poorly suited	
		Slope	0.50	Rock fragments	0.50
				Slope	0.50
Heiser--------------	25	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
117:					
Sandy, Typic Torriorthents------	100	Well suited		Well suited	
118:					
Shinume-------------	85	Unsuited		Poorly suited	
		Restrictive layer	1.00	Rock fragments	0.50
		Slope	0.50	Slope	0.50

Table 14.—Land Management, Part III (Site Preparation)—Continued

Map unit symbol and soil name	Pct. of map unit	Suitability for mechanical site preparation (deep)		Suitability for mechanical site preparation (surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value
119:					
Trachute, tephra	80	Well suited		Well suited	
Lava flows, basalt	10	Not rated		Not rated	
120:					
Tsosie, tephra	85	Well suited		Poorly suited	
				Rock fragments	0.50
121:					
Vitrandic Torriorthents	100	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
				Rock fragments	0.50

Table 14.—Land Management, Part IV (Site Restoration)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Potential for damage to soil by fire: Rating class and limiting features	Value	Potential for seedling mortality: Rating class and limiting features	Value
100:					
Bighawk	100	Low		High	
				Available water	1.00
				Soil reaction	0.50
101:					
Bighawk family, tephra	85	High		High	
		Texture/surface layer thickness/rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
102:					
Chedeski, tephra	90	Low		High	
				Available water	1.00
				Soil reaction	0.50
103:					
Flaco, tephra	90	High		High	
		Texture/surface layer thickness/rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
104:					
Flaco, tephra	75	High		High	
		Texture/surface layer thickness/rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
Lava flows, basalt	10	Not rated		Not rated	
105:					
Flaco, tephra	65	High		Moderate	
		Texture/surface layer thickness/rock fragments	1.00	Available water	0.50
				Carbonate content	0.50
				Soil reaction	0.50
Pocum, tephra	25	High		High	
		Texture/surface layer thickness/rock fragments	1.00	Available water	1.00
				Carbonate content	0.50
				Soil reaction	0.50
106:					
Gish, tephra	90	High		Moderate	
		Texture/surface layer thickness/rock fragments	1.00	Available water	0.50

Table 14.—Land Management, Part IV (Site Restoration)—Continued

Map unit symbol and soil name	Pct. of map unit	Potential for damage to soil by fire: Rating class and limiting features	Value	Potential for seedling mortality: Rating class and limiting features	Value
107:					
Ives	60	Moderate		High	
		Texture/rock fragments	0.50	Available water	1.00
Riverwash	20	Not rated		Not rated	
108:					
Meriwhitica	75	High		High	
		Texture/slope/ surface layer thickness	1.00	Available water	1.00
				Soil reaction	0.50
Rock outcrop, limestone	25	Not rated		Not rated	
109:					
Miburn, tephra	85	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00
110:					
Miburn, tephra	45	High		High	
		Texture/rock fragments	1.00	Available water	1.00
Cambidic Haplodurids	40	High		High	
		Texture/rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
111:					
Miburn, tephra	50	High		Moderate	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	0.50
Heiser	35	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00
Lava flows, basalt	10	Not rated		Not rated	
112:					
Moenkopie	45	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00
				Soil reaction	1.00
Typic Haplocambids, tephra	40	High		High	
		Texture/surface layer thickness rock fragments	1.00	Available water	1.00
				Soil reaction	0.50

Table 14.—Land Management, Part IV (Site Restoration)—Continued

Map unit symbol and soil name	Pct. of map unit	Potential for damage to soil by fire: Rating class and limiting features	Value	Potential for seedling mortality: Rating class and limiting features	Value
113:					
Moenkopie	70	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
Rock outcrop, sandstone	20	Not rated		Not rated	
114:					
Nalakihu	85	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
115:					
Peshlaki	75	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
Rock outcrop, limestone	10	Not rated		Not rated	
116:					
Rock outcrop, sandstone	35	Not rated		Not rated	
Typic Torriorthents	30	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
Heiser	25	High		High	
		Texture/rock fragments	1.00	Available water	1.00
117:					
Sandy, Typic Torriorthents	100	Low		High	
				Available water	1.00
118:					
Shinume	85	Moderate		Moderate	
		Texture/surface layer thickness/ rock fragments	0.50	Available water	0.50
119:					
Trachute, tephra	80	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00
				Soil reaction	0.50
Lava flows, basalt	10	Not rated		Not rated	

Table 14.—Land Management, Part IV (Site Restoration)—Continued

Map unit symbol and soil name	Pct. of map unit	Potential for damage to soil by fire		Potential for seedling mortality	
		Rating class and limiting features	Value	Rating class and limiting features	Value
120:					
Tsosie, tephra------	85	High		Moderate	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	0.50
121:					
Vitrandic Torriorthents------	100	High		High	
		Texture/surface layer thickness/ rock fragments	1.00	Available water	1.00

Table 15.—Recreation, Part I (Camp and Picnic Areas)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value
100:					
Bighawk	100	Somewhat limited		Somewhat limited	
		Gravel content	0.08	Gravel content	0.08
		Dusty	0.05	Dusty	0.05
101:					
Bighawk family, tephra	85	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Gravel content	0.05	Gravel content	0.05
102:					
Chedeski, tephra	90	Very limited		Very limited	
		Gravel content	1.00	Gravel content	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Dusty	0.14	Dusty	0.14
103:					
Flaco, tephra	90	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Gravel content	1.00	Gravel content	1.00
		Dusty	0.13	Dusty	0.13
104:					
Flaco, tephra	75	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Dusty	0.20	Dusty	0.20
		Large stones content	0.01	Large stones content	0.01
Lava flows, basalt	10	Not rated		Not rated	
105:					
Flaco, tephra	65	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Dusty	0.10	Dusty	0.10
Pocum, tephra	25	Very limited		Very limited	
		Depth to cemented pan	1.00	Too sandy	1.00
		Too sandy	1.00	Depth to cemented pan	1.00
		Slow water movement	0.26	Slow water movement	0.26
		Gravel content	0.08	Gravel content	0.08
		Dusty	0.08	Dusty	0.08
106:					
Gish, tephra	90	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Gravel content	0.61	Gravel content	0.61
		Slow water movement	0.41	Slow water movement	0.41
		Dusty	0.16	Dusty	0.16

Table 15.—Recreation, Part I (Camp and Picnic Areas)—Continued

Map unit symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value
107:					
Ives	60	Very limited		Somewhat limited	
		Flooding	1.00	Dusty	0.01
		Dusty	0.01		
Riverwash	20	Not rated		Not rated	
108:					
Meriwhitica	75	Very limited		Very limited	
		Large stones content	1.00	Large stones content	1.00
		Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Gravel content	0.99	Gravel content	0.99
		Too sandy	0.60	Too sandy	0.60
Rock outcrop, limestone	25	Not rated		Not rated	
109:					
Miburn, tephra	85	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
110:					
Miburn, tephra	45	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
Cambidic Haplodurids	40	Very limited		Very limited	
		Slow water movement	1.00	Slow water movement	1.00
		Too sandy	0.88	Too sandy	0.88
111:					
Miburn, tephra	50	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Slope	1.00	Slope	1.00
Heiser	35	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Slope	1.00	Slope	1.00
Lava flows, basalt	10	Not rated		Not rated	
112:					
Moenkopie	45	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Gravel content	0.13	Gravel content	0.13
		Dusty	0.13	Dusty	0.13
		Large stones content	0.02	Large stones content	0.02
Typic Haplocambids, tephra	40	Somewhat limited		Somewhat limited	
		Too sandy	0.88	Too sandy	0.88

Table 15.—Recreation, Part I (Camp and Picnic Areas)—Continued

Map unit symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value
113:					
Moenkopie	70	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Too sandy	0.98	Too sandy	0.98
Rock outcrop, sandstone	20	Not rated		Not rated	
114:					
Nalakihu	85	Somewhat limited		Somewhat limited	
		Too sandy	0.88	Too sandy	0.88
		Dusty	0.03	Dusty	0.03
115:					
Peshlaki	75	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Gravel content	1.00	Gravel content	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
Rock outcrop, limestone	10	Not rated		Not rated	
116:					
Rock outcrop, sandstone	35	Not rated		Not rated	
Typic Torriorthents	30	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Dusty	0.24	Dusty	0.24
		Gravel content	0.10	Gravel content	0.10
Heiser	25	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Slope	1.00	Slope	1.00
117:					
Sandy, Typic Torriorthents	100	Somewhat limited		Somewhat limited	
		Gravel content	0.16	Gravel content	0.16
118:					
Shinume	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00
		Dusty	0.02	Dusty	0.02
119:					
Trachute, tephra	80	Very limited		Somewhat limited	
		Flooding	1.00	Too sandy	0.98
		Too sandy	0.98	Dusty	0.01
		Dusty	0.01		
Lava flows, basalt	10	Not rated		Not rated	
120:					
Tsosie, tephra	85	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Gravel content	0.61	Gravel content	0.61
		Dusty	0.26	Dusty	0.26

Table 15.—Recreation, Part I (Camp and Picnic Areas)—Continued

Map unit symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value
121:					
Vitrandic Torriorthents	100	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Slope	1.00	Slope	1.00
		Gravel content	0.05	Gravel content	0.05

Table 15.—Recreation, Part II (Trail Management)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Foot traffic and equestrian trails: Rating class and limiting features	Value	Mountain bike and off-road vehicle trails: Rating class and limiting features	Value
100:					
Bighawk	100	Somewhat limited		Somewhat limited	
		Dusty	0.05	Dusty	0.05
101:					
Bighawk family, tephra	85	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
102:					
Chedeski, tephra	90	Somewhat limited		Somewhat limited	
		Dusty	0.14	Dusty	0.14
103:					
Flaco, tephra	90	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Dusty	0.13	Dusty	0.13
104:					
Flaco, tephra	75	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Dusty	0.20	Dusty	0.20
		Large stones content	0.01	Large stones content	0.01
Lava flows, basalt	10	Not rated		Not rated	
105:					
Flaco, tephra	65	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Dusty	0.10	Dusty	0.10
Pocum, tephra	25	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Dusty	0.08	Dusty	0.08
106:					
Gish, tephra	90	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Dusty	0.16	Dusty	0.16
107:					
Ives	60	Somewhat limited		Somewhat limited	
		Dusty	0.01	Dusty	0.01
Riverwash	20	Not rated		Not rated	
108:					
Meriwhitica	75	Very limited		Very limited	
		Large stones content	1.00	Large stones content	1.00
		Slope	1.00	Too sandy	0.60
		Too sandy	0.60	Slope	0.22

Table 15.—Recreation, Part II (Trail Management)—Continued

Map unit symbol and soil name	Pct. of map unit	Foot traffic and equestrian trails: Rating class and limiting features	Value	Mountain bike and off-road vehicle trails: Rating class and limiting features	Value
108:					
Rock outcrop, limestone	25	Not rated		Not rated	
109:					
Miburn, tephra	85	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
110:					
Miburn, tephra	45	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
Cambidic Haplodurids	40	Somewhat limited		Somewhat limited	
		Too sandy	0.88	Too sandy	0.88
111:					
Miburn, tephra	50	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Slope	1.00		
Heiser	35	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
Lava flows, basalt	10	Not rated		Not rated	
112:					
Moenkopie	45	Somewhat limited		Somewhat limited	
		Dusty	0.13	Dusty	0.13
		Large stones content	0.02	Large stones content	0.02
Typic Haplocambids, tephra	40	Somewhat limited		Somewhat limited	
		Too sandy	0.88	Too sandy	0.88
113:					
Moenkopie	70	Somewhat limited		Somewhat limited	
		Too sandy	0.98	Too sandy	0.98
Rock outcrop, sandstone	20	Not rated		Not rated	
114:					
Nalakihu	85	Somewhat limited		Somewhat limited	
		Too sandy	0.88	Too sandy	0.88
		Dusty	0.03	Dusty	0.03
115:					
Peshlaki	75	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
Rock outcrop, limestone	10	Not rated		Not rated	

Table 15.—Recreation, Part II (Trail Management)—Continued

Map unit symbol and soil name	Pct. of map unit	Foot traffic and equestrian trails: Rating class and limiting features	Value	Mountain bike and off-road vehicle trails: Rating class and limiting features	Value
116:					
Rock outcrop, sandstone	35	Not rated		Not rated	
Typic Torriorthents	30	Somewhat limited		Somewhat limited	
		Slope	0.50	Dusty	0.24
		Dusty	0.24		
Heiser	25	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Slope	0.02		
117:					
Sandy, Typic Torriorthents	100	Not limited		Not limited	
118:					
Shinume	85	Somewhat limited		Somewhat limited	
		Slope	0.08	Dusty	0.02
		Dusty	0.02		
119:					
Trachute, tephra	80	Somewhat limited		Somewhat limited	
		Too sandy	0.98	Too sandy	0.98
		Dusty	0.01	Dusty	0.01
Lava flows, basalt	10	Not rated		Not rated	
120:					
Tsosie, tephra	85	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Dusty	0.26	Dusty	0.26
121:					
Vitrandic Torriorthents	100	Very limited		Very limited	
		Too sandy	1.00	Too sandy	1.00
		Slope	1.00	Slope	0.01

Table 16.—Dwellings and Small Commercial Buildings

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Dwellings without basements: Rating class and limiting features	Value	Dwellings with basements: Rating class and limiting features	Value	Small commercial buildings: Rating class and limiting features	Value
100:							
Bighawk	100	Not limited		Not limited		Not limited	
101:							
Bighawk family, tephra	85	Not limited		Somewhat limited		Not limited	
				Depth to hard bedrock	0.77		
102:							
Chedeski, tephra	90	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.71	Depth to hard bedrock	1.00	Depth to soft bedrock	1.00
		Depth to soft bedrock	0.50	Depth to soft bedrock	1.00	Depth to hard bedrock	0.71
103:							
Flaco, tephra	90	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.35	Depth to hard bedrock	1.00	Depth to hard bedrock	0.35
104:							
Flaco, tephra	75	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.35	Depth to hard bedrock	1.00	Depth to hard bedrock	0.35
Lava flows, basalt	10	Not rated		Not rated		Not rated	
105:							
Flaco, tephra	65	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.84	Depth to hard bedrock	1.00	Depth to hard bedrock	0.84
Pocum, tephra	25	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.84	Depth to hard bedrock	1.00	Depth to hard bedrock	0.84
106:							
Gish, tephra	90	Somewhat limited		Somewhat limited		Somewhat limited	
		Shrink-swell	0.88	Shrink-swell	0.96	Shrink-swell	0.88
107:							
Ives	60	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Flooding	1.00
Riverwash	20	Not rated		Not rated		Not rated	
108:							
Meriwhitica	75	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
Rock outcrop, limestone	25	Not rated		Not rated		Not rated	

Table 16.—Dwellings and Small Commercial Buildings—Continued

Map unit symbol and soil name	Pct. of map unit	Dwellings without basements		Dwellings with basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
109:							
Miburn, tephra	85	Not limited		Not limited		Not limited	
110:							
Miburn, tephra	45	Not limited		Not limited		Somewhat limited	
						Slope	0.50
Cambidic Haplodurids	40	Not limited		Not limited		Somewhat limited	
						Slope	0.88
111:							
Miburn, tephra	50	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to hard bedrock	1.00	Slope	1.00
		Depth to hard bedrock	0.97	Slope	1.00	Depth to hard bedrock	0.97
Heiser	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
Lava flows, basalt	10	Not rated		Not rated		Not rated	
112:							
Moenkopie	45	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
Typic Haplocambids, tephra	40	Not limited		Somewhat limited		Not limited	
				Depth to hard bedrock	0.96		
113:							
Moenkopie	70	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Depth to soft bedrock	0.50	Depth to soft bedrock	1.00	Depth to soft bedrock	1.00
Rock outcrop, sandstone	20	Not rated		Not rated		Not rated	
114:							
Nalakihu	85	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.77	Depth to hard bedrock	1.00	Depth to hard bedrock	0.77
115:							
Peshlaki	75	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
Rock outcrop, limestone	10	Not rated		Not rated		Not rated	
116:							
Rock outcrop, sandstone	35	Not rated		Not rated		Not rated	

Table 16.—Dwellings and Small Commercial Buildings—Continued

Map unit symbol and soil name	Pct. of map unit	Dwellings without basements: Rating class and limiting features	Value	Dwellings with basements: Rating class and limiting features	Value	Small commercial buildings: Rating class and limiting features	Value
116:							
Typic Torriorthents	30	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00	Depth to soft bedrock	1.00
		Depth to soft bedrock	0.50	Slope	1.00	Slope	1.00
		Large stones	0.08	Large stones	0.08	Large stones	0.08
Heiser	25	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
117:							
Sandy, Typic Torriorthents	100	Not limited		Not limited		Not limited	
118:							
Shinume	85	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Large stones	0.04	Large stones	0.04	Large stones	0.04
119:							
Trachute, tephra	80	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Flooding	1.00
Lava flows, basalt	10	Not rated		Not rated		Not rated	
120:							
Tsosie, tephra	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Shrink-swell	0.15	Shrink-swell	0.13	Shrink-swell	0.15
121:							
Vitrandic Torriorthents	100	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00

Table 17.—Roads and Streets, Shallow Excavations, and Landscaping

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Local roads and streets: Rating class and limiting features	Value	Shallow excavations: Rating class and limiting features	Value	Landscaping: Rating class and limiting features	Value
100:							
Bighawk	100	Not limited		Somewhat limited		Somewhat limited	
				Dusty	0.05	Droughty	0.88
				Unstable excavation walls	0.01	Gravel content	0.08
						Dusty	0.05
101:							
Bighawk family, tephra	85	Not limited		Somewhat limited		Somewhat limited	
				Depth to hard bedrock	0.77	Too sandy	0.50
				Unstable excavation walls	0.49	Gravel content	0.05
102:							
Chedeski, tephra	90	Somewhat limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to hard bedrock	1.00	Droughty	1.00
		Depth to hard bedrock	0.71	Depth to soft bedrock	1.00	Depth to bedrock	1.00
		Frost action	0.50	Dusty	0.14	Gravel content	1.00
				Unstable excavation walls	0.01	Dusty	0.14
103:							
Flaco, tephra	90	Somewhat limited		Very limited		Very limited	
		Frost action	0.50	Depth to hard bedrock	1.00	Too sandy	1.00
		Depth to hard bedrock	0.35	Dusty	0.13	Gravel content	1.00
				Unstable excavation walls	0.01	Carbonate content	1.00
						Depth to bedrock	0.35
						Droughty	0.34
104:							
Flaco, tephra	75	Somewhat limited		Very limited		Very limited	
		Frost action	0.50	Depth to hard bedrock	1.00	Too sandy	1.00
		Depth to hard bedrock	0.35	Dusty	0.20	Large stones content	0.95
				Unstable excavation walls	0.01	Depth to bedrock	0.35
						Dusty	0.20
						Droughty	0.07
Lava flows, basalt	10	Not rated		Not rated		Not rated	
105:							
Flaco, tephra	65	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.84	Depth to hard bedrock	1.00	Depth to bedrock	0.84
		Frost action	0.50	Dusty	0.10	Too sandy	0.50
				Unstable excavation walls	0.01	Droughty	0.12
						Dusty	0.10

Table 17.—Roads and Streets, Shallow Excavations, and Landscaping—Continued

Map unit symbol and soil name	Pct. of map unit	Local roads and streets: Rating class and limiting features	Value	Shallow excavations: Rating class and limiting features	Value	Landscaping: Rating class and limiting features	Value
105:							
Pocum, tephra	25	Somewhat limited		Very limited		Very limited	
		Depth to hard bedrock	0.84	Depth to hard bedrock	1.00	Depth to cemented pan	1.00
		Frost action	0.50	Dusty	0.08	Too sandy	1.00
				Unstable excavation walls	0.01	Droughty	1.00
						Depth to bedrock	0.84
						Gravel content	0.08
106:							
Gish, tephra	90	Very limited		Somewhat limited		Very limited	
		Low strength	1.00	Dusty	0.16	Too sandy	1.00
		Shrink-swell	0.88	Unstable excavation walls	0.01	Gravel content	0.61
						Dusty	0.16
107:							
Ives	60	Somewhat limited		Somewhat limited		Somewhat limited	
		Frost action	0.50	Dusty	0.01	Droughty	0.25
		Flooding	0.40	Unstable excavation walls	0.01	Dusty	0.01
Riverwash	20	Not rated		Not rated		Not rated	
108:							
Meriwhitica	75	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Droughty	1.00
						Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Unstable excavation walls	0.01	Gravel content	0.99
Rock outcrop, limestone	25	Not rated		Not rated		Not rated	
109:							
Miburn, tephra	85	Not limited		Somewhat limited		Very limited	
				Unstable excavation walls	0.01	Too sandy	1.00
						Droughty	0.83
110:							
Miburn, tephra	45	Not limited		Somewhat limited		Very limited	
				Unstable excavation walls	0.88	Too sandy	1.00
						Droughty	1.00
Cambidic Haplodurids	40	Very limited		Somewhat limited		Very limited	
		Low strength	1.00	Unstable excavation walls	0.79	Droughty	1.00
111:							
Miburn, tephra	50	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to hard bedrock	1.00	Too sandy	1.00
		Depth to hard bedrock	0.97			Droughty	1.00
				Slope	1.00	Slope	1.00
				Unstable excavation walls	0.01	Depth to bedrock	0.97
						Large stones content	0.32

Table 17.—Roads and Streets, Shallow Excavations, and Landscaping—Continued

Map unit symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
111:							
Heiser	35	Very limited		Very limited		Very limited	
		Slope	1.00	Unstable excavation walls	1.00	Too sandy	1.00
						Droughty	1.00
				Slope	1.00	Slope	1.00
Lava flows, basalt	10	Not rated		Not rated		Not rated	
112:							
Moenkopie	45	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Droughty	1.00
						Depth to bedrock	1.00
		Frost action	0.50	Dusty	0.13	Large stones content	1.00
				Unstable excavation walls	0.01		
						Gravel content	0.13
						Dusty	0.13
Typic Haplocambids, tephra	40	Somewhat limited		Somewhat limited		Somewhat limited	
		Frost action	0.50	Depth to hard bedrock	0.96	Droughty	0.91
				Unstable excavation walls	0.21		
113:							
Moenkopie	70	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
						Droughty	1.00
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Too sandy	0.50
				Unstable excavation walls	0.87		
Rock outcrop, sandstone	20	Not rated		Not rated		Not rated	
114:							
Nalakihu	85	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.77	Depth to hard bedrock	1.00	Depth to bedrock	0.77
						Droughty	0.34
		Frost action	0.50	Dusty	0.03	Large stones content	0.03
				Unstable excavation walls	0.01		
						Dusty	0.03
115:							
Peshlaki	75	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Too sandy	1.00
						Droughty	1.00
				Unstable excavation walls	0.01	Depth to bedrock	1.00
						Gravel content	1.00
Rock outcrop, limestone	10	Not rated		Not rated		Not rated	
116:							
Rock outcrop, sandstone	35	Not rated		Not rated		Not rated	

Table 17.—Roads and Streets, Shallow Excavations, and Landscaping—Continued

Map unit symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
116:							
Typic Torriorthents	30	Very limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Droughty	1.00
		Slope	1.00	Slope	1.00	Depth to bedrock	1.00
		Frost action	0.50	Dusty	0.24	Slope	1.00
		Large stones	0.08	Large stones	0.08	Large stones content	0.32
				Unstable excavation walls	0.01	Dusty	0.24
Heiser	25	Very limited		Very limited		Very limited	
		Slope	1.00	Unstable excavation walls	1.00	Too sandy	1.00
				Slope	1.00	Droughty	1.00
						Slope	1.00
117:							
Sandy, Typic Torriorthents	100	Not limited		Very limited		Somewhat limited	
				Unstable excavation walls	1.00	Droughty	0.97
						Gravel content	0.16
118:							
Shinume	85	Very limited		Very limited		Very limited	
		Depth to hard bedrock	1.00	Depth to hard bedrock	1.00	Depth to bedrock	1.00
		Slope	1.00	Slope	1.00	Droughty	1.00
		Frost action	0.50	Large stones	0.04	Slope	1.00
		Large stones	0.04	Dusty	0.02	Large stones content	0.39
				Unstable excavation walls	0.01	Dusty	0.02
119:							
Trachute, tephra	80	Somewhat limited		Somewhat limited		Somewhat limited	
		Frost action	0.50	Unstable excavation walls	0.01	Too sandy	0.50
		Flooding	0.20	Dusty	0.01	Dusty	0.01
Lava flows, basalt	10	Not rated		Not rated		Not rated	
120:							
Tsosie, tephra	85	Very limited		Somewhat limited		Very limited	
		Low strength	1.00	Dusty	0.26	Too sandy	1.00
		Frost action	0.50	Unstable excavation walls	0.01	Gravel content	0.61
		Shrink-swell	0.15			Dusty	0.26
121:							
Vitrandic Torriorthents	100	Very limited		Very limited		Very limited	
		Slope	1.00	Unstable excavation walls	1.00	Too sandy	1.00
				Slope	1.00	Droughty	1.00
						Slope	1.00
						Gravel content	0.05

Table 18.—Sewage Disposal

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields: Rating class and limiting features	Value	Sewage lagoons: Rating class and limiting features	Value
100:					
Bighawk	100	Not limited		Very limited	
				Seepage	1.00
101:					
Bighawk family, tephra	85	Somewhat limited		Very limited	
		Depth to bedrock	0.91	Seepage	1.00
				Depth to hard bedrock	0.77
				Slope	0.08
102:					
Chedeski, tephra	90	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
				Depth to soft bedrock	1.00
103:					
Flaco, tephra	90	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slow water movement	0.50	Seepage	0.50
104:					
Flaco, tephra	75	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slow water movement	0.50	Seepage	0.50
				Slope	0.32
Lava flows, basalt	10	Not rated		Not rated	
105:					
Flaco, tephra	65	Very limited		Very limited	
		Slow water movement	1.00	Depth to hard bedrock	1.00
		Depth to bedrock	1.00		
Pocum, tephra	25	Very limited		Very limited	
		Depth to cemented pan	1.00	Depth to hard bedrock	1.00
		Depth to bedrock	1.00	Depth to cemented pan	1.00
				Seepage	0.50
106:					
Gish, tephra	90	Very limited		Not limited	
		Slow water movement	1.00		

Table 18.—Sewage Disposal—Continued

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields: Rating class and limiting features	Value	Sewage lagoons: Rating class and limiting features	Value
107:					
Ives	60	Somewhat limited		Very limited	
		Flooding	0.40	Seepage	1.00
				Flooding	0.40
Riverwash	20	Not rated		Not rated	
108:					
Meriwhitica	75	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
Rock outcrop, limestone	25	Not rated		Not rated	
109:					
Miburn, tephra	85	Somewhat limited		Very limited	
		Slow water movement	0.50	Seepage	1.00
				Slope	0.32
110:					
Miburn, tephra	45	Not limited		Very limited	
				Seepage	1.00
				Slope	0.92
Cambidic Haplodurids	40	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
111:					
Miburn, tephra	50	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
				Seepage	1.00
Heiser	35	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
Lava flows, basalt	10	Not rated		Not rated	
112:					
Moenkopie	45	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
				Large stones	0.01
Typic Haplocambids, tephra	40	Somewhat limited		Very limited	
		Depth to bedrock	0.99	Seepage	1.00
		Slow water movement	0.50	Depth to hard bedrock	0.96

Table 18.—Sewage Disposal—Continued

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields: Rating class and limiting features	Value	Sewage lagoons: Rating class and limiting features	Value
113:					
Moenkopie	70	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
				Depth to soft bedrock	1.00
				Seepage	1.00
				Slope	0.08
Rock outcrop, sandstone	20	Not rated		Not rated	
114:					
Nalakihu	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slow water movement	0.50	Seepage	0.50
115:					
Peshlaki	75	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
Rock outcrop, limestone	10	Not rated		Not rated	
116:					
Rock outcrop, sandstone	35	Not rated		Not rated	
Typic Torriorthents	30	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
		Large stones	0.08	Large stones	0.77
Heiser	25	Very limited		Very limited	
		Filtering capacity	1.00	Seepage	1.00
		Slope	1.00	Slope	1.00
117:					
Sandy, Typic Torriorthents	100	Not limited		Very limited	
				Seepage	1.00
				Depth to soft bedrock	0.68
				Slope	0.32
118:					
Shinume	85	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	1.00	Slope	1.00
		Large stones	0.04	Large stones	0.60
				Seepage	0.50

Table 18.—Sewage Disposal—Continued

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields: Rating class and limiting features	Value	Sewage lagoons: Rating class and limiting features	Value
119:					
Trachute, tephra----	80	Somewhat limited		Very limited	
		Flooding	0.20	Seepage	1.00
				Flooding	0.20
Lava flows, basalt--	10	Not rated		Not rated	
120:					
Tsosie, tephra------	85	Very limited		Not limited	
		Slow water movement	1.00		
121:					
Vitrandic Torriorthents------	100	Very limited		Very limited	
		Filtering capacity	1.00	Slope	1.00
				Seepage	1.00
		Slope	1.00		

Table 19.—Source of Gravel and Sand

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The ratings given for the thickest layer are for the thickest layer above and excluding the bottom layer. The numbers in the value columns range from 0.00 to 0.99. The greater the value, the greater the likelihood that the bottom layer or thickest layer of the soil is a source of sand or gravel. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Gravel source: Rating class and limiting features	Gravel source: Value	Sand source: Rating class and limiting features	Sand source: Value
100:					
Bighawk	100	Fair		Fair	
		Thickest layer	0.00	Bottom layer	0.04
		Bottom layer	0.20	Thickest layer	0.09
101:					
Bighawk family, tephra	85	Poor		Fair	
		Thickest layer	0.00	Bottom layer	0.11
		Bottom layer	0.00	Thickest layer	0.35
102:					
Chedeski, tephra	90	Poor		Fair	
		Thickest layer	0.00	Bottom layer	0.00
		Bottom layer	0.00	Thickest layer	0.04
103:					
Flaco, tephra	90	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.01
		Thickest layer	0.00	Thickest layer	0.05
104:					
Flaco, tephra	75	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Lava flows, basalt	10	Not rated		Not rated	
105:					
Flaco, tephra	65	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.05
Pocum, tephra	25	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.01
		Thickest layer	0.00	Thickest layer	0.07
106:					
Gish, tephra	90	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
107:					
Ives	60	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.12
		Thickest layer	0.00	Thickest layer	0.18
Riverwash	20	Not rated		Not rated	

Table 19.—Source of Gravel and Sand—Continued

Map unit symbol and soil name	Pct. of map unit	Gravel source: Rating class and limiting features	Gravel source: Value	Sand source: Rating class and limiting features	Sand source: Value
108:					
Meriwhitica	75	Fair		Fair	
		Thickest layer	0.00	Bottom layer	0.10
		Bottom layer	0.58	Thickest layer	0.13
Rock outcrop, limestone	25	Not rated		Not rated	
109:					
Miburn, tephra	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.09
		Thickest layer	0.00	Thickest layer	0.26
110:					
Miburn, tephra	45	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.58
		Thickest layer	0.00	Thickest layer	0.74
Cambidic Haplodurids	40	Not rated		Fair	
				Bottom layer	0.00
				Thickest layer	0.50
111:					
Miburn, tephra	50	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.05
		Thickest layer	0.00	Thickest layer	0.16
Heiser	35	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.70
		Thickest layer	0.00	Thickest layer	0.99
Lava flows, basalt	10	Not rated		Not rated	
112:					
Moenkopie	45	Poor		Fair	
		Thickest layer	0.00	Bottom layer	0.00
		Bottom layer	0.00	Thickest layer	0.04
Typic Haplocambids, tephra	40	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.11
		Thickest layer	0.00	Thickest layer	0.23
113:					
Moenkopie	70	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.12
		Thickest layer	0.00	Thickest layer	0.54
Rock outcrop, sandstone	20	Not rated		Not rated	
114:					
Nalakihu	85	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.07

Table 19.—Source of Gravel and Sand—Continued

Map unit symbol and soil name	Pct. of map unit	Gravel source: Rating class and limiting features	Gravel source: Value	Sand source: Rating class and limiting features	Sand source: Value
115:					
Peshlaki	75	Poor		Fair	
		Thickest layer	0.00	Bottom layer	0.10
		Bottom layer	0.00	Thickest layer	0.64
Rock outcrop, limestone	10	Not rated		Not rated	
116:					
Rock outcrop, sandstone	35	Not rated		Not rated	
Typic Torriorthents	30	Poor		Poor	
		Thickest layer	0.00	Bottom layer	0.00
		Bottom layer	0.00	Thickest layer	0.00
Heiser	25	Poor		Fair	
		Thickest layer	0.00	Bottom layer	0.86
		Bottom layer	0.00	Thickest layer	0.99
117:					
Sandy, Typic Torriorthents	100	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.27
		Thickest layer	0.00	Thickest layer	0.98
118:					
Shinume	85	Fair		Fair	
		Thickest layer	0.00	Bottom layer	0.03
		Bottom layer	0.03	Thickest layer	0.10
119:					
Trachute, tephra	80	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.01
		Thickest layer	0.00	Thickest layer	0.10
Lava flows, basalt	10	Not rated		Not rated	
120:					
Tsosie, tephra	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
121:					
Vitrandic Torriorthents	100	Fair		Fair	
		Thickest layer	0.00	Bottom layer	0.78
		Bottom layer	0.15	Thickest layer	0.99

Table 20.—Source of Reclamation Material, Roadfill, and Topsoil

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.00 to 0.99. The smaller the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material: Rating class and limiting features	Value	Roadfill source: Rating class and limiting features	Value	Topsoil source: Rating class and limiting features	Value
100:							
Bighawk	100	Poor		Good		Poor	
		Too alkaline	0.00			Rock fragments	0.00
		Low content of organic matter	0.08			Hard to reclaim (rock fragments)	0.00
		Droughty	0.13			Exchange capacity	0.68
101:							
Bighawk family, tephra	85	Poor		Fair		Poor	
		Wind erosion	0.00	Depth to bedrock	0.23	Rock fragments	0.00
		Too alkaline	0.00			Too sandy	0.06
		Too sandy	0.06			Exchange capacity	0.49
102:							
Chedeski, tephra	90	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Dusty	0.98	Rock fragments	0.00
		Too alkaline	0.00			Exchange capacity	0.62
103:							
Flaco, tephra	90	Poor		Poor		Poor	
		Wind erosion	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Too alkaline	0.00	Dusty	0.98	Depth to bedrock	0.65
		Carbonate content	0.00			Carbonate content	0.94
104:							
Flaco, tephra	75	Poor		Poor		Fair	
		Wind erosion	0.00	Depth to bedrock	0.00	Rock fragments	0.12
		Too alkaline	0.00	Dusty	0.93	Depth to bedrock	0.65
		Low content of organic matter	0.08			Exchange capacity	0.92
Lava flows, basalt	10	Not rated		Not rated		Not rated	
105:							
Flaco, tephra	65	Poor		Poor		Fair	
		Wind erosion	0.00	Depth to bedrock	0.00	Depth to bedrock	0.16
		Too alkaline	0.00			Carbonate content	0.89
		Droughty	0.07			Exchange capacity	0.93
Pocum, tephra	25	Poor		Poor		Poor	
		Wind erosion	0.00	Depth to cemented pan	0.00	Depth to cemented pan	0.00
		Droughty	0.00	Depth to bedrock	0.00	Rock fragments	0.06
		Depth to cemented pan	0.00			Depth to bedrock	0.16
106:							
Gish, tephra	90	Poor		Poor		Fair	
		Wind erosion	0.00	Low strength	0.00	Too clayey	0.50
		Low content of organic matter	0.08	Shrink-swell	0.63		
		Too clayey	0.62	Dusty	0.96		

Table 20.—Source of Reclamation Material, Roadfill, and Topsoil—Continued

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material: Rating class and limiting features	Value	Roadfill source: Rating class and limiting features	Value	Topsoil source: Rating class and limiting features	Value
107:							
Ives	60	Fair		Fair		Fair	
		Low content of organic matter	0.08	Dusty	0.88	Rock fragments	0.59
		Droughty	0.54			Exchange capacity	0.59
Riverwash	20	Not rated		Not rated		Not rated	
108:							
Meriwhitica	75	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Depth to bedrock	0.00	Slope	0.00	Depth to bedrock	0.00
		Low content of organic matter	0.08			Slope	0.00
Rock outcrop, limestone	25	Not rated		Not rated		Not rated	
109:							
Miburn, tephra	85	Poor		Fair		Fair	
		Wind erosion	0.00	Dusty	0.91	Exchange capacity	0.10
		Too alkaline	0.00			Too sandy	0.17
		Low content of organic matter	0.08			Rock fragments	0.81
110:							
Miburn, tephra	45	Poor		Fair		Poor	
		Too sandy	0.00	Dusty	0.91	Too sandy	0.00
		Wind erosion	0.00			Rock fragments	0.05
		Droughty	0.00			Exchange capacity	0.12
Cambidic Haplodurids	40	Poor		Poor		Not rated	
		Too sandy	0.00	Low strength	0.00		
		Wind erosion	0.00	Dusty	0.91		
		Droughty	0.00				
111:							
Miburn, tephra	50	Poor		Poor		Poor	
		Wind erosion	0.00	Depth to bedrock	0.00	Slope	0.00
		Droughty	0.00	Slope	0.00	Depth to bedrock	0.03
		Too alkaline	0.00	Dusty	0.91	Exchange capacity	0.08
Heiser	35	Poor		Fair		Poor	
		Too sandy	0.00	Dusty	0.91	Too sandy	0.00
		Wind erosion	0.00			Slope	0.00
		Droughty	0.00			Exchange capacity	0.14
Lava flows, basalt	10	Not rated		Not rated		Not rated	
112:							
Moenkopie	45	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Dusty	0.82	Rock fragments	0.01
		Too alkaline	0.00	Cobble content	0.97	Exchange capacity	0.17
Typic Haplocambids, tephra	40	Poor		Fair		Fair	
		Wind erosion	0.00	Depth to bedrock	0.04	Rock fragments	0.02
		Droughty	0.00	Dusty	0.91	Too sandy	0.25
		Too alkaline	0.00			Exchange capacity	0.75

Table 20.—Source of Reclamation Material, Roadfill, and Topsoil—Continued

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material: Rating class and limiting features	Value	Roadfill source: Rating class and limiting features	Value	Topsoil source: Rating class and limiting features	Value
113:							
Moenkopie	70	Poor		Poor		Poor	
		Too sandy	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Wind erosion	0.00	Dusty	0.91	Too sandy	0.00
		Droughty	0.00			Exchange capacity	0.19
Rock outcrop, sandstone	20	Not rated		Not rated		Not rated	
114:							
Nalakihu	85	Poor		Poor		Fair	
		Wind erosion	0.00	Depth to bedrock	0.00	Depth to bedrock	0.23
		Too alkaline	0.00	Dusty	0.87	Rock fragments	0.72
		Droughty	0.01			Exchange capacity	0.85
115:							
Peshlaki	75	Poor		Poor		Poor	
		Too sandy	0.00	Depth to bedrock	0.00	Too sandy	0.00
		Droughty	0.00			Depth to bedrock	0.00
		Depth to bedrock	0.00			Rock fragments	0.00
Rock outcrop, limestone	10	Not rated		Not rated		Not rated	
116:							
Rock outcrop, sandstone	35	Not rated		Not rated		Not rated	
Typic Torriorthents	30	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Cobble content	0.13	Rock fragments	0.00
		Low content of organic matter	0.08	Slope	0.50	Slope	0.00
Heiser	25	Poor		Fair		Poor	
		Too sandy	0.00	Dusty	0.91	Too sandy	0.00
		Wind erosion	0.00	Slope	0.98	Slope	0.00
		Droughty	0.00			Exchange capacity	0.27
117:							
Sandy, Typic Torriorthents	100	Poor		Fair		Poor	
		Too sandy	0.00	Dusty	0.91	Too sandy	0.00
		Droughty	0.00			Exchange capacity	0.42
		Low content of organic matter	0.08			Rock fragments	0.67
118:							
Shinume	85	Poor		Poor		Poor	
		Droughty	0.00	Depth to bedrock	0.00	Depth to bedrock	0.00
		Depth to bedrock	0.00	Cobble content	0.23	Rock fragments	0.00
		Low content of organic matter	0.08	Dusty	0.88	Slope	0.00

Table 20.—Source of Reclamation Material, Roadfill, and Topsoil—Continued

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material: Rating class and limiting features	Value	Roadfill source: Rating class and limiting features	Value	Topsoil source: Rating class and limiting features	Value
119:							
Trachute, tephra----	80	Poor		Fair		Fair	
		Wind erosion	0.00	Dusty	0.89	Exchange capacity	0.84
		Too alkaline	0.00			Too sandy	0.99
		Low content of organic matter	0.08				
Lava flows, basalt--	10	Not rated		Not rated		Not rated	
120:							
Tsosie, tephra------	85	Poor		Poor		Good	
		Wind erosion	0.00	Low strength	0.00		
		Low content of organic matter	0.50	Dusty	0.88		
				Shrink-swell	0.97		
121:							
Vitrandic Torriorthents------	100	Poor		Poor		Poor	
		Wind erosion	0.00	Slope	0.00	Rock fragments	0.00
		Droughty	0.00			Hard to reclaim (rock fragments)	0.00
		Too sandy	0.00				
						Slope	0.00

Table 21.—Ponds and Embankments

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
100:							
Bighawk	100	Very limited		Very limited		Very limited	
		Seepage	1.00	Seepage	1.00	Depth to water	1.00
				Dusty	0.05		
101:							
Bighawk family, tephra	85	Very limited		Very limited		Very limited	
		Seepage	1.00	Seepage	1.00	Depth to water	1.00
		Depth to bedrock	0.22	Piping	1.00		
				Thin layer	0.22		
102:							
Chedeski, tephra	90	Somewhat limited		Very limited		Very limited	
		Depth to bedrock	0.93	Thin layer	1.00	Depth to water	1.00
		Seepage	0.04	Dusty	0.14		
103:							
Flaco, tephra	90	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.83	Thin layer	0.83	Depth to water	1.00
		Seepage	0.70	Seepage	0.16		
				Dusty	0.13		
104:							
Flaco, tephra	75	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.83	Thin layer	0.83	Depth to water	1.00
		Seepage	0.70	Piping	0.50		
		Slope	0.08	Dusty	0.20		
Lava flows, basalt	10	Not rated		Not rated		Not rated	
105:							
Flaco, tephra	65	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.96	Thin layer	0.96	Depth to water	1.00
		Seepage	0.03	Dusty	0.10		
Pocum, tephra	25	Very limited		Very limited		Very limited	
		Depth to cemented pan	1.00	Thin layer	1.00	Depth to water	1.00
		Depth to bedrock	0.96	Dusty	0.08		
		Seepage	0.70				
106:							
Gish, tephra	90	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.03	Dusty	0.16	Depth to water	1.00
107:							
Ives	60	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.99	Depth to water	1.00
				Dusty	0.01		
Riverwash	20	Not rated		Not rated		Not rated	

Table 21.—Ponds and Embankments—Continued

Map unit symbol and soil name	Pct. of map unit	Pond reservoir areas: Rating class and limiting features	Value	Embankments, dikes, and levees: Rating class and limiting features	Value	Aquifer-fed excavated ponds: Rating class and limiting features	Value
108:							
Meriwhitica	75	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Seepage	1.00	Depth to water	1.00
		Slope	1.00	Thin layer	1.00		
Rock outcrop, limestone	25	Not rated		Not rated		Not rated	
109:							
Miburn, tephra	85	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Seepage	0.64	Depth to water	1.00
		Slope	0.08				
110:							
Miburn, tephra	45	Very limited		Very limited		Very limited	
		Seepage	1.00	Seepage	1.00	Depth to water	1.00
		Slope	0.68	Piping	1.00		
Cambidic Haplodurids	40	Somewhat limited		Very limited		Very limited	
		Slope	0.92	Piping	1.00	Depth to water	1.00
				Seepage	0.70		
111:							
Miburn, tephra	50	Very limited		Somewhat limited		Very limited	
		Seepage	1.00	Thin layer	0.99	Depth to water	1.00
		Slope	1.00				
		Depth to bedrock	0.99				
Heiser	35	Very limited		Very limited		Very limited	
		Seepage	1.00	Seepage	1.00	Depth to water	1.00
		Slope	1.00				
Lava flows, basalt	10	Not rated		Not rated		Not rated	
112:							
Moenkopie	45	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
				Dusty	0.13		
Typic Haplocambids, tephra	40	Very limited		Very limited		Very limited	
		Seepage	1.00	Seepage	1.00	Depth to water	1.00
		Depth to bedrock	0.37	Piping	1.00		
				Thin layer	0.37		
113:							
Moenkopie	70	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Seepage	1.00	Depth to water	1.00
				Piping	1.00		
				Thin layer	1.00		
Rock outcrop, sandstone	20	Not rated		Not rated		Not rated	
114:							
Nalakihu	85	Somewhat limited		Somewhat limited		Very limited	
		Depth to bedrock	0.94	Thin layer	0.94	Depth to water	1.00
		Seepage	0.70	Dusty	0.03		

Table 21.—Ponds and Embankments—Continued

Map unit symbol and soil name	Pct. of map unit	Pond reservoir areas: Rating class and limiting features	Value	Embankments, dikes, and levees: Rating class and limiting features	Value	Aquifer-fed excavated ponds: Rating class and limiting features	Value
115:							
Peshlaki	75	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Thin layer	1.00	Depth to water	1.00
Rock outcrop, limestone	10	Not rated		Not rated		Not rated	
116:							
Rock outcrop, sandstone	35	Not rated		Not rated		Not rated	
Typic Torriorthents	30	Very limited		Very limited		Very limited	
		Slope	1.00	Thin layer	1.00	Depth to water	1.00
		Depth to bedrock	0.77	Seepage	0.30		
				Dusty	0.24		
				Large stones	0.08		
Heiser	25	Very limited		Very limited		Very limited	
		Seepage	1.00	Seepage	1.00	Depth to water	1.00
		Slope	1.00				
117:							
Sandy, Typic Torriorthents	100	Very limited		Very limited		Very limited	
		Seepage	1.00	Seepage	1.00	Depth to water	1.00
		Slope	0.08	Thin layer	0.18		
		Depth to bedrock	0.01				
118:							
Shinume	85	Very limited		Very limited		Very limited	
		Depth to bedrock	1.00	Seepage	1.00	Depth to water	1.00
		Slope	1.00	Thin layer	1.00		
				Large stones	0.04		
				Dusty	0.02		
119:							
Trachute, tephra	80	Very limited		Very limited		Very limited	
		Seepage	1.00	Piping	1.00	Depth to water	1.00
				Dusty	0.01		
Lava flows, basalt	10	Not rated		Not rated		Not rated	
120:							
Tsosie, tephra	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.03	Dusty	0.26	Depth to water	1.00
121:							
Vitrandic Torriorthents	100	Very limited		Very limited		Very limited	
		Seepage	1.00	Seepage	1.00	Depth to water	1.00
		Slope	1.00				

Table 22.—Engineering Properties

(Data for the representative texture is shown in this report. The representative texture is the most commonly occurring one found in a particular soil horizon or layer. Only one representative texture is assigned to a horizon or layer. Interpretations using texture criteria only consider the representative texture. Other textures occurring in the soil are described in the section "Detailed Soil Map Units." Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>250 mm	70-250 mm	4	10	40	200		
	Cm				Pct	Pct					Pct	
100:												
Bighawk---------	0-5	Gravelly sandy loam	SC-SM	A-2-4	0	0	37-81	35-80	23-63	11-34	0-26	NP-9
	5-30	Very gravelly sandy loam	GC	A-2-4	0	0	28-81	25-80	18-71	9-41	21-29	6-12
	30-47	Very stony sandy loam	SC	A-2-4	0-28	0	32-81	29-80	21-70	11-41	21-29	6-12
	47-60	Very gravelly sandy loam	GC	A-2-4	0	0	28-81	25-80	18-70	10-42	21-29	6-12
	60-152	Extremely gravelly sandy loam	GC-GM	A-2-4	0	0	28-81	25-80	18-71	9-40	21-29	6-12
101:												
Bighawk family, tephra---------	0-5	Gravelly sand	SP-SM	A-3	0	0	29-86	26-86	20-70	3-14	0-19	NP-3
	5-21	Very gravelly sand	SP-SM	A-2-4	0	0	28-85	25-85	19-68	2-12	0-18	NP-3
	21-32	Loam	CL	A-6	0	0	79-100	79-100	66-93	45-66	28-38	12-19
	32-74	Extremely gravelly loamy sand	GP-GM	A-1-b	0	0-17	28-80	25-79	18-66	5-24	0-24	NP-7
	74-117	Gravelly loamy sand	SM	A-2-4	0	0	19-84	15-83	12-70	3-22	0-24	NP-7
	117-142	Bedrock	---	---	---	---	---	---	---	---	---	---
102:												
Chedeski, tephra	0-5	Very gravelly sandy loam	GC-GM	A-2-4	0	0	29-70	26-68	19-57	10-32	20-30	4-12
	5-33	Gravelly sandy clay loam	SC	A-2-6	0	0	45-83	43-82	35-78	19-49	31-45	14-25
	33-69	Bedrock	---	---	---	---	---	---	---	---	---	---
	69-94	Bedrock	---	---	---	---	---	---	---	---	---	---
103:												
Flaco, tephra---	0-3	Extremely gravelly coarse sand	GP	A-1-a	0	0	39-86	36-86	16-42	3-11	0-21	NP-4
	3-15	Gravelly sandy loam	SC	A-6	0	0	76-95	75-95	52-75	31-49	19-29	4-12
	15-25	Sandy clay loam	CL	A-7-6	0	0	68-100	67-100	51-88	28-53	34-46	16-25
	25-51	Gravelly sandy clay loam	GC	A-2-6	0	0-14	58-83	57-82	44-73	23-44	28-41	12-21
	51-79	Gravelly sandy loam	GC	A-2-6	0	0	52-84	50-83	36-66	20-40	24-33	9-15
	79-104	Bedrock	---	---	---	---	---	---	---	---	---	---
104:												
Flaco, tephra---	0-3	Very stony coarse sand	SP-SM	A-1-b	0-41	0	57-86	55-86	24-42	5-11	0-21	NP-4
	3-18	Very gravelly sandy loam	GC	A-2-6	0	0-13	48-91	46-91	32-72	19-47	19-29	4-12
	18-25	Gravelly sandy clay loam	SC	A-6	0	0-15	73-100	72-100	57-91	32-56	34-46	16-25
	25-46	Gravelly loam	CL	A-6	0	3-14	58-86	57-85	48-83	35-63	28-41	12-21
	46-79	Gravelly loam	CL	A-6	0	3-14	58-86	57-85	47-78	34-58	24-33	9-15
	79-104	Bedrock	---	---	---	---	---	---	---	---	---	---

Table 22.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >250 mm	Fragments: 70-250 mm	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	Cm				Pct	Pct					Pct	
105:												
Flaco, tephra---	0-5	Sand	SP-SM	A-3	0	0	53-100	51-100	39-79	5-12	0-18	NP-2
	5-15	Sandy clay loam	SC	A-6	0	0	74-100	73-100	62-89	35-52	30-36	13-17
	15-36	Sandy clay loam	SC	A-6	0	0	69-95	68-95	52-83	28-50	30-43	13-23
	36-64	Gravelly sandy clay loam	SC	A-6	0	0	69-100	68-100	56-94	30-57	30-43	13-23
	64-89	Bedrock	---	---	---	---	---	---	---	---	---	---
Pocum, tephra---	0-5	Gravelly coarse sand	SP-SM	A-1-b	0	0	39-85	37-84	16-39	3-9	0-18	NP-2
	5-23	Gravelly sandy clay loam	SC	A-6	0	0	62-91	60-91	48-85	25-52	25-41	9-21
	23-46	Gravelly sandy loam	SC	A-2-4	0	7-14	60-91	58-91	44-77	26-49	25-36	9-17
	46-56	Cemented material	---	---	---	---	---	---	---	---	---	---
	56-64	Gravelly sandy loam	GC	A-2-6	0	0	58-84	56-83	41-69	24-43	25-36	9-17
	64-89	Bedrock	---	---	---	---	---	---	---	---	---	---
106:												
Gish, tephra----	0-2	Very gravelly coarse sand	SW-SM	A-1-b	0	0	44-91	41-90	18-42	3-9	0-14	NP
	2-9	Loamy coarse sand, gravelly coarse sandy loam	SC-SM	A-2-4	0	0	71-90	70-90	32-53	11-25	0-27	NP-9
	9-39	Clay, sandy clay loam, clay loam	CL	A-7-6	0	0	91-100	91-100	71-96	46-68	38-55	19-33
	39-76	Clay loam, clay, sandy clay loam	CL	A-7-6	0	0	91-100	91-100	73-98	41-63	38-55	19-33
	76-152	Sandy clay loam, clay loam, clay	CH	A-7-6	0	0	90-100	90-100	77-100	49-71	38-55	19-33
107:												
Ives------------	0-12	Sandy clay loam	SC	A-6	0	0	59-100	57-100	46-88	22-45	30-39	13-19
	12-24	Gravelly sandy loam, loamy sand, sandy loam	SC	A-2-4	0	0	59-100	57-100	39-80	16-40	19-31	4-13
	24-61	Sandy loam, loamy sand, gravelly sandy loam	SC	A-2-6	0	0	59-100	57-100	37-77	14-37	19-31	4-13
	61-152	Sandy loam, gravelly sandy loam, loamy sand	SC	A-2-4	0	0	59-100	57-100	43-87	8-27	19-31	4-13
108:												
Meriwhitica-----	0-5	Very gravelly loamy sand	GC-GM	A-1-b	0	0	31-78	28-77	21-66	6-23	17-27	2-9
	5-18	Gravelly sandy loam	SC-SM	A-2-4	0-15	0-15	12-76	8-75	6-60	3-31	16-26	2-9
	18-28	Extremely gravelly loamy sand	GP-GM	A-1-a	0	0	10-54	6-52	5-43	1-14	16-22	2-6
	28-53	Bedrock	---	---	---	---	---	---	---	---	---	---

Table 22.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >250 mm	Fragments: 70-250 mm	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	Cm				Pct	Pct					Pct	
109:												
Miburn, tephra--	0-7	Coarse sand	SP-SM	A-1-b	0	0	78-100	77-100	33-47	6-11	0-17	NP-2
	7-26	Fine sand	SM	A-2-4	0	0	78-100	77-100	71-96	10-18	0-17	NP-2
	26-58	Channery sandy loam	SC-SM	A-2-4	0	0-11	64-100	63-100	44-78	21-42	15-25	1-8
	58-114	Gravelly loamy sand	SM	A-2-4	0	0	59-92	57-92	43-76	12-27	0-23	NP-6
	114-152	Gravelly sandy loam	SC-SM	A-2-4	0	4-7	62-79	60-79	39-58	12-22	0-23	NP-6
110:												
Miburn, tephra--	0-26	Coarse sand	SW-SM	A-1-b	0	0	92-100	92-100	39-45	6-9	0-17	NP-1
	26-37	Sandy loam, gravelly loamy sand, gravelly sandy loam	SC-SM	A-2-4	0	0	58-100	56-100	40-78	16-36	19-26	4-9
	37-71	Loamy sand, gravelly loamy sand	SM	A-1-b	0	0	59-100	57-100	43-80	12-26	0-20	NP-4
	71-117	Gravelly loamy sand, very cobbly loamy sand	SM	A-1-b	0	7-31	55-84	54-83	40-67	12-23	0-20	NP-4
	117-152	Very gravelly sand, gravelly sand	SP-SM	A-2-4	0	0-13	62-92	60-92	45-74	5-13	0-20	NP-4
Cambidic Haplodurids----	0-18	Loamy sand	SC-SM	A-2-4	0	0	92-100	92-100	67-81	14-23	0-22	NP-6
	18-44	Loamy sand	SM	A-2-4	0	0	92-100	92-100	69-80	20-27	0-20	NP-4
	44-79	Cemented material	---	---	---	---	---	---	---	---	---	---
	79-107	Cemented material	---	---	---	---	---	---	---	---	---	---
	107-152	Cemented material	---	---	---	---	---	---	---	---	---	---
111:												
Miburn, tephra--	0-10	Channery coarse sand	SP-SM	A-1-b	0-11	0-22	79-100	79-100	36-50	6-12	0-18	NP-3
	10-18	Stony coarse sand, coarse sand	SW-SM	A-1-b	0-12	0-23	81-100	80-100	35-47	6-11	0-17	NP-2
	18-56	Gravelly sandy loam	SC	A-2-4	0	0-14	67-100	65-100	45-78	19-38	19-28	4-11
	56-81	Bedrock	---	---	---	---	---	---	---	---	---	---
111:												
Heiser----------	0-5	Gravelly coarse sand	SP-SM	A-1-b	0	0	72-100	71-100	33-49	6-11	0-17	NP-2
	5-152	Coarse sand	SW-SM	A-1-b	0	0	95-100	95-100	43-48	10-13	0-17	NP-2

Table 22.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >250 mm	Fragments: 70-250 mm	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	Cm				Pct	Pct					Pct	
112:												
Moenkopie-------	0-4	Very channery sandy clay loam	GC	A-2-6	4-10	8-23	40-86	38-85	31-78	16-45	27-38	11-19
	4-9	Very channery sandy loam, channery sandy clay loam	SC	A-6	0	13-37	41-85	40-85	31-75	17-44	27-38	11-19
	9-34	Bedrock	---	---	---	---	---	---	---	---	---	---
Typic Haplocambids, tephra---------	0-7	Gravelly loamy sand	SM	A-2-4	0	0	54-92	52-92	39-75	12-26	15-22	1-6
	7-24	Gravelly loamy sand, gravelly sandy loam	SC-SM	A-2-4	0	0	52-76	50-75	36-62	16-32	19-29	4-12
	24-42	Gravelly sandy loam	SC	A-2-4	0	0	52-76	50-75	35-60	15-30	19-29	4-12
	42-80	Gravelly sandy loam, gravelly loamy sand	SM	A-2-4	0	0-6	57-92	56-92	42-75	12-26	15-22	1-6
	80-107	Gravelly loamy sand, gravelly sandy loam	SC-SM	A-2-4	0	0-13	62-78	60-77	46-63	11-18	15-22	1-6
	107-132	Bedrock	---	---	---	---	---	---	---	---	---	---
113:												
Moenkopie-------	0-5	Channery sandy loam, loamy coarse sand	SM	A-1-b	0	0-7	76-100	75-100	36-55	9-19	0-22	NP-6
	5-33	Channery sandy loam, channery loamy coarse sand	SM	A-1-b	0	0-24	69-100	68-100	38-63	13-27	0-22	NP-6
	33-42	Bedrock	---	---	---	---	---	---	---	---	---	---
	42-67	Bedrock	---	---	---	---	---	---	---	---	---	---
114:												
Nalakihu--------	0-7	Loamy sand	SM	A-2-4	0	0-15	83-100	82-100	61-78	13-20	0-19	NP-3
	7-17	Gravelly sandy loam	SC	A-2-6	0	0-14	67-100	65-100	46-83	18-40	25-38	9-19
	17-42	Sandy clay loam	SC	A-6	0	0-23	80-100	79-100	64-90	31-48	28-38	12-19
	42-67	Gravelly loam	SC	A-6	0	0-15	73-100	72-100	60-94	40-65	28-38	12-19
	67-92	Bedrock	---	---	---	---	---	---	---	---	---	---
115:												
Peshlaki--------	0-3	Extremely gravelly coarse sand	GP	A-1-a	0	0	24-68	21-66	9-32	2-8	0-19	NP-3
	3-18	Very gravelly loamy sand	SM	A-1-b	0	0	44-77	41-76	31-61	9-21	0-21	NP-5
	18-43	Bedrock	---	---	---	---	---	---	---	---	---	---

Table 22.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >250 mm	Fragments: 70-250 mm	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	Cm				Pct	Pct					Pct	
116:												
Typic Torriorthents--	0-10	Channery sandy clay loam	SC	A-2-6	0	0-24	51-91	50-91	42-86	23-50	30-41	13-21
	10-31	Extremely channery clay loam	GC	A-2-6	0	25-44	22-66	20-65	18-63	13-48	35-45	18-25
	31-56	Bedrock	---	---	---	---	---	---	---	---	---	---
Heiser----------	0-26	Coarse sand	SP-SM	A-1-b	0	0	65-100	63-100	28-50	4-12	0-19	NP-3
	26-97	Gravelly coarse sand	SP-SM	A-1-b	0	0	54-100	52-100	23-48	3-10	0-17	NP-2
	97-152	Gravelly coarse sand	SP-SM	A-1-b	0	0	44-100	41-100	18-47	3-11	0-17	NP-2
117:												
Sandy, Typic Torriorthents--	0-8	Gravelly sandy loam	SC	A-2-6	0	0	52-76	50-75	34-59	16-31	21-31	6-13
	8-48	Fine sand, extremely gravelly loamy coarse sand, sand	SP-SM	A-3	0	0-11	25-100	22-100	17-83	2-15	0-20	NP-4
	48-63	Fine sand, extremely gravelly sand, sand	GP	A-1-a	0	0	23-54	20-52	15-43	2-9	0-20	NP-4
	63-120	Fine sand, extremely gravelly loamy coarse sand, sand	SP-SM	A-2-4	0	0-6	57-100	56-100	51-98	6-17	0-20	NP-4
	120-145	Bedrock	---	---	---	---	---	---	---	---	---	---
118:												
Shinume---------	0-6	Channery sandy clay loam	SC	A-6	0	13-19	76-85	75-85	61-77	31-44	30-41	13-21
	6-12	Channery sandy loam	SC	A-2-4	0	12-36	43-86	42-86	30-67	13-33	22-29	7-12
	12-27	Very channery sandy loam	GC	A-2-6	0	24-36	43-67	42-67	29-50	12-24	22-29	7-12
	27-40	Very channery sandy loam	GC	A-2-4	0	24-36	43-67	42-67	30-52	13-25	22-29	7-12
	40-65	Bedrock	---	---	---	---	---	---	---	---	---	---
119:												
Trachute, tephra	0-4	Sandy loam, loamy coarse sand	SC-SM	A-1-b	0	0	85-100	84-100	35-50	7-17	15-24	1-7
	4-29	Sandy loam, loamy coarse sand	SC	A-2-4	0	0	84-100	83-100	55-80	22-40	15-29	1-12
	29-80	Fine sandy loam, loamy coarse sand	SC-SM	A-4	0	0	84-100	83-100	70-98	28-48	15-29	1-12
	80-152	Fine sandy loam, loamy coarse sand	SM	A-4	0	0	84-100	83-100	72-95	34-48	15-24	1-7

Table 22.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >250 mm	Fragments: 70-250 mm	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	Cm				Pct	Pct					Pct	
120:												
Tsosie, tephra--	0-2	Very gravelly coarse sand	SP-SM	A-1-b	0	0	39-91	36-90	18-72	4-38	21-52	1-25
	2-18	Gravelly loam	SC	A-6	0	0	74-100	73-100	65-99	46-74	37-51	16-25
	18-30	Clay loam	CL	A-7-6	0	0	100	100	85-96	62-73	35-50	16-25
	30-102	Clay loam	CL	A-6	0	0	100	100	86-97	63-74	34-47	16-25
	102-152	Clay loam	CL	A-6	0	0	100	100	86-97	63-74	34-46	16-25
121:												
Vitrandic Torriorthents--	0-3	Gravelly coarse sand	SP-SM	A-1-b	0	0	24-72	21-71	9-35	2-9	0-19	NP-3
	3-20	Gravelly loamy coarse sand	SM	A-1-b	0	0	63-91	61-90	33-58	11-26	0-23	NP-7
	20-152	Extremely gravelly coarse sand	GP	A-1-a	0	0	14-68	10-66	5-39	1-15	0-27	NP-10

Table 23.—Physical Soil Properties

(Sand, silt, and clay values are shown either as a range or as a representative value. Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct
100:									
Bighawk---------	0-2	60-70	16-34	2-14	1.35-1.50	2.0-5.9	0.06-0.09	0.1-1.1	0.6-1.0
	2-12	60-70	12-30	10-18	1.35-1.50	2.0-5.9	0.05-0.08	0.2-2.2	0.1-0.5
	12-19	60-70	12-30	10-18	1.35-1.50	2.0-5.9	0.05-0.09	0.2-2.2	0.1-0.5
	19-24	60-65	17-30	10-18	1.35-1.50	2.0-5.9	0.05-0.08	0.2-2.2	0.1-0.5
	24-60	60-70	12-30	10-18	1.35-1.50	2.0-5.9	0.04-0.07	0.2-2.2	0.1-0.5
101:									
Bighawk family, tephra---------	0-2	90-95	1-9	1-6	1.45-1.60	20.0-99.9	0.02-0.04	0.0-0.5	0.6-1.0
	2-8	90-95	0-9	1-6	1.35-1.50	20.0-99.9	0.06-0.10	0.0-0.4	0.1-0.5
	8-13	45-65	17-37	18-27	1.25-1.40	0.6-2.0	0.14-0.19	1.3-3.2	0.1-0.5
	13-29	80-90	0-17	3-12	1.25-1.40	2.0-5.9	0.10-0.13	0.1-0.9	0.1-0.5
	29-46	80-90	0-17	3-12	1.35-1.50	2.0-5.9	0.06-0.09	0.1-1.0	0.1-0.5
	46-56	---	---	---	---	0.0-0.1	---	---	---
102:									
Chedeski, tephra	0-2	45-65	17-38	8-18	1.35-1.50	5.9-20.0	0.05-0.08	0.3-1.5	0.6-1.0
	2-13	45-55	10-30	21-35	1.25-1.40	0.2-0.6	0.11-0.15	1.4-4.6	0.1-0.5
	13-27	---	---	---	---	0.2-0.6	---	---	---
	27-37	---	---	---	---	0.0-0.2	---	---	---
103:									
Flaco, tephra---	0-1	90-95	0-7	3-8	1.45-1.60	20.0-99.9	0.02-0.04	0.1-0.6	0.6-1.0
	1-6	50-60	22-38	8-18	1.35-1.50	2.0-5.9	0.06-0.10	0.5-1.8	0.1-0.5
	6-10	50-60	5-23	24-35	1.25-1.40	0.2-0.6	0.14-0.19	2.3-5.1	0.1-0.5
	10-20	50-60	10-28	18-30	1.25-1.40	0.2-0.6	0.10-0.13	1.2-3.7	0.1-0.5
	20-31	55-65	13-30	14-22	1.35-1.50	0.6-2.0	0.06-0.09	0.9-2.4	0.1-0.5
	31-41	---	---	---	---	0.0-0.1	---	---	---
104:									
Flaco, tephra---	0-1	90-95	0-7	3-8	1.45-1.60	20.0-99.9	0.02-0.04	0.1-0.6	0.6-1.0
	1-7	50-60	22-38	8-18	1.35-1.50	2.0-5.9	0.05-0.09	0.4-1.8	0.1-0.5
	7-10	50-60	5-26	24-35	1.25-1.40	0.2-0.6	0.12-0.16	2.1-5.1	0.1-0.5
	10-18	35-45	27-47	18-30	1.25-1.40	0.6-2.0	0.11-0.15	1.2-3.7	0.1-0.5
	18-31	35-45	33-49	14-22	1.25-1.40	0.6-2.0	0.11-0.15	0.9-2.4	0.1-0.5
	31-41	---	---	---	---	0.0-0.1	---	---	---
105:									
Flaco, tephra---	0-2	90-95	0-7	2-5	1.45-1.60	20.0-99.9	0.05-0.07	0.1-0.4	0.6-1.0
	2-6	50-60	15-28	20-25	1.25-1.40	0.2-0.6	0.13-0.17	1.7-3.2	0.1-0.5
	6-14	50-60	8-26	20-32	1.25-1.40	0.2-0.6	0.13-0.17	1.6-4.3	0.1-0.5
	14-25	50-60	8-29	20-32	1.25-1.40	0.2-0.6	0.12-0.16	1.6-4.5	0.1-0.5
	25-35	---	---	---	---	0.0-0.1	---	---	---

Table 23.—Physical Soil Properties—Continued

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct
105:									
Pocum, tephra---	0-2	92-95	0-6	2-5	1.45-1.60	20.0-99.9	0.02-0.06	0.1-0.4	0.6-1.0
	2-9	50-60	10-33	15-30	1.25-1.40	0.2-0.6	0.12-0.16	1.2-3.8	0.1-0.5
	9-18	55-65	14-30	15-25	1.35-1.50	0.6-2.0	0.06-0.10	1.1-2.8	0.1-0.5
	18-22	---	---	---	---	0.0-0.1	---	---	---
	22-25	55-65	12-30	15-25	1.35-1.50	0.6-2.0	0.06-0.10	1.2-2.8	0.1-0.5
	25-35	---	---	---	---	0.0-0.1	---	---	---
106:									
Gish, tephra----	0-1	92-98	0-7	1-3	1.45-1.60	20.0-99.9	0.02-0.04	0.0-0.2	0.6-1.0
	1-4	70-92	0-25	3-15	1.35-1.50	5.9-20.0	0.05-0.09	0.2-1.4	0.1-0.8
	4-15	35-60	0-37	28-45	1.25-1.40	0.2-0.6	0.17-0.21	3.4-7.2	0.1-0.5
	15-30	35-60	0-33	28-45	1.25-1.40	0.2-0.6	0.14-0.19	3.4-7.2	0.1-0.5
	30-60	35-60	0-36	28-45	1.15-1.30	0.0-0.2	0.14-0.16	3.4-7.2	0.1-0.5
107:									
Ives------------	0-5	55-70	2-22	20-28	1.25-1.60	0.2-0.6	0.13-0.17	1.6-3.8	0.1-0.6
	5-9	60-90	0-32	8-20	1.35-1.60	2.0-5.9	0.08-0.13	0.5-2.4	0.1-0.5
	9-24	60-90	0-32	8-20	1.35-1.60	2.0-5.9	0.06-0.10	0.5-2.4	0.1-0.5
	24-60	60-90	0-22	8-20	1.45-1.60	2.0-5.9	0.05-0.07	0.5-2.4	0.1-0.5
108:									
Meriwhitica-----	0-2	78-85	0-17	5-15	1.45-1.60	20.0-99.9	0.03-0.05	0.2-1.3	0.6-1.0
	2-7	65-70	15-27	5-15	1.35-1.50	2.0-5.9	0.06-0.10	0.0-1.3	0.1-0.5
	7-11	80-85	5-14	5-10	1.45-1.60	20.0-99.9	0.03-0.04	0.0-0.6	0.1-0.5
	11-21	---	---	---	---	0.0-0.1	---	---	---
109:									
Miburn, tephra--	0-3	92-97	0-7	1-5	1.45-1.60	5.9-20.0	0.03-0.07	0.1-0.4	0.1-0.6
	3-10	90-95	1-9	1-5	1.45-1.60	5.9-20.0	0.05-0.07	0.1-0.4	0.1-0.5
	10-23	55-90	1-41	4-13	1.35-1.50	0.6-2.0	0.07-0.11	0.2-1.3	0.1-0.5
	23-45	55-90	0-34	3-11	1.45-1.60	2.0-5.9	0.04-0.06	0.2-1.0	0.1-0.5
	45-60	80-85	4-16	3-11	1.35-1.50	0.6-2.0	0.07-0.11	0.2-0.9	0.1-0.5
110:									
Miburn, tephra--	0-10	90-96	0-7	1-4	1.45-1.60	5.9-20.0	0.03-0.07	0.1-0.3	0.2-0.6
	10-15	65-85	1-27	8-14	1.35-1.50	0.6-2.0	0.06-0.10	0.5-1.4	0.1-0.5
	15-28	75-95	0-22	3-8	1.45-1.60	2.0-5.9	0.04-0.05	0.2-0.7	0.1-0.5
	28-46	80-95	0-17	3-8	1.45-1.60	2.0-5.9	0.03-0.04	0.1-0.6	0.1-0.5
	46-60	90-95	0-7	3-8	1.45-1.60	5.9-20.0	0.04-0.07	0.2-0.7	0.1-0.5
Cambidic Haplodurids----	0-7	80-90	0-15	2-10	1.45-1.60	5.9-20.0	0.05-0.07	0.1-0.9	0.2-0.6
	7-17	85-90	5-12	3-8	1.45-1.60	0.0-0.0	0.05-0.07	0.2-0.7	0.1-0.5
	17-31	---	---	---	---	0.0-0.0	---	---	---
	31-42	---	---	---	---	0.0-0.0	---	---	---
	42-60	---	---	---	---	0.0-0.0	---	---	---

Table 23.—Physical Soil Properties—Continued

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct
111:									
Miburn, tephra	0-4	90-95	0-8	2-6	1.45-1.60	5.9-20.0	0.03-0.06	0.1-0.5	0.1-0.6
	4-7	90-95	0-8	1-5	1.45-1.60	5.9-20.0	0.03-0.07	0.0-0.4	0.1-0.5
	7-22	65-75	8-25	8-17	1.35-1.50	0.6-2.0	0.07-0.11	0.5-1.8	0.1-0.5
	22-32	---	---	---	---	0.0-20.0	---	---	---
Heiser	0-2	90-95	0-7	2-5	1.45-1.60	5.9-20.0	0.03-0.07	0.1-0.3	0.1-0.6
	2-60	90-95	1-8	2-5	1.45-1.60	5.9-20.0	0.03-0.07	0.1-0.3	0.1-0.5
112:									
Moenkopie	0-2	52-65	8-30	17-27	1.25-1.40	0.2-0.6	0.08-0.11	0.7-3.0	0.1-0.6
	2-4	52-65	8-31	17-27	1.25-1.40	0.2-0.6	0.12-0.16	0.7-3.0	0.1-0.5
	4-13	---	---	---	---	0.0-0.2	---	---	---
Typic Haplocambids, tephra	0-3	85-95	1-11	4-10	1.45-1.60	5.9-20.0	0.04-0.06	0.2-0.9	0.1-0.6
	3-9	55-80	2-36	8-18	1.35-1.50	0.6-2.0	0.06-0.10	0.5-1.6	0.1-0.5
	9-17	55-80	2-34	8-18	1.35-1.50	0.6-2.0	0.06-0.10	0.5-1.6	0.1-0.5
	17-31	55-90	0-35	4-10	1.45-1.60	0.6-2.0	0.04-0.05	0.2-0.9	0.1-0.5
	31-42	55-90	0-35	4-10	1.45-1.60	2.0-5.9	0.04-0.05	0.2-0.8	0.1-0.5
	42-52	---	---	---	---	0.2-2.0	---	---	---
113:									
Moenkopie	0-2	85-95	0-12	3-10	1.45-1.60	5.9-20.0	0.05-0.06	0.2-1.0	0.1-0.6
	2-13	85-95	2-12	3-10	1.45-1.60	2.0-5.9	0.04-0.06	0.2-1.0	0.1-0.5
	13-17	---	---	---	---	0.0-0.2	---	---	---
	17-26	---	---	---	---	0.0-0.2	---	---	---
114:									
Nalakihu	0-3	85-96	1-12	3-7	1.45-1.60	5.9-99.9	0.05-0.06	0.2-0.6	0.1-0.6
	3-7	65-85	0-20	15-27	1.35-1.50	0.6-2.0	0.07-0.11	1.0-3.6	0.1-0.5
	7-17	45-80	0-35	18-27	1.25-1.40	0.6-2.0	0.13-0.17	1.3-3.6	0.1-0.5
	17-26	45-80	2-37	18-27	1.25-1.40	0.6-2.0	0.10-0.14	1.3-3.6	0.1-0.5
	26-36	---	---	---	---	0.0-0.1	---	---	---
115:									
Peshlaki	0-1	92-95	0-7	1-6	1.45-1.60	20.0-99.9	0.02-0.04	0.0-0.3	0.6-1.0
	1-7	80-90	1-17	3-10	1.45-1.60	5.9-20.0	0.03-0.04	0.1-0.6	0.1-0.5
	7-17	---	---	---	---	0.0-0.1	---	---	---
116:									
Typic Torriorthents	0-4	52-70	4-28	20-30	1.25-1.40	0.6-2.0	0.10-0.13	1.2-3.9	0.1-0.6
	4-12	40-45	26-33	27-35	1.25-1.40	0.2-0.6	0.09-0.11	0.6-3.2	0.1-0.5
	12-22	---	---	---	---	0.0-0.1	---	---	---

Table 23.—Physical Soil Properties—Continued

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct
116:									
Heiser----------	0-10	90-95	0-7	2-7	1.45-1.60	5.9-20.0	0.03-0.06	0.1-0.3	0.1-0.6
	10-38	90-95	0-7	1-5	1.45-1.60	5.9-20.0	0.03-0.06	0.1-0.3	0.1-0.5
	38-60	90-95	0-8	1-5	1.45-1.60	5.9-20.0	0.02-0.05	0.1-0.3	0.1-0.5
117:									
Sandy, Typic Torriorthents--	0-3	60-80	1-30	10-20	1.35-1.50	0.6-2.0	0.06-0.09	0.5-1.8	0.1-0.6
	3-19	85-97	0-12	2-8	1.45-1.60	2.0-5.9	0.05-0.08	0.0-0.7	0.1-0.5
	19-25	85-97	0-13	2-8	1.45-1.60	2.0-5.9	0.03-0.04	0.0-0.4	0.1-0.5
	25-47	85-97	0-10	2-8	1.45-1.60	5.9-20.0	0.05-0.08	0.1-0.7	0.1-0.5
	47-57	---	---	---	---	0.0-0.2	---	---	---
118:									
Shinume---------	0-2	55-70	3-25	20-30	1.25-1.40	0.6-2.0	0.10-0.13	1.4-3.5	0.1-0.6
	2-5	65-80	4-23	12-18	1.35-1.50	0.6-2.0	0.06-0.10	0.4-1.6	0.1-0.5
	5-11	65-80	2-23	12-18	1.35-1.50	0.6-2.0	0.06-0.10	0.4-1.2	0.1-0.5
	11-16	65-80	4-23	12-18	1.35-1.50	0.6-2.0	0.06-0.10	0.4-1.2	0.1-0.5
	16-26	---	---	---	---	0.0-0.2	---	---	---
119:									
Trachute, tephra	0-2	75-92	0-15	4-12	1.45-1.60	2.0-5.9	0.05-0.07	0.3-1.2	0.1-0.6
	2-11	60-90	0-36	4-18	1.35-1.50	2.0-5.9	0.08-0.12	0.2-1.6	0.1-0.5
	11-31	60-90	0-36	4-18	1.35-1.50	2.0-5.9	0.08-0.15	0.3-1.9	0.1-0.5
	31-60	60-90	6-36	4-12	1.35-1.50	2.0-5.9	0.08-0.15	0.3-1.2	0.1-0.5
120:									
Tsosie, tephra--	0-1	90-95	0-6	4-35	1.45-1.60	20.0-99.9	0.02-0.04	0.1-4.8	2.5-3.5
	1-7	45-55	21-31	24-35	1.25-1.40	0.6-2.0	0.10-0.14	2.3-5.4	1.5-3.0
	7-12	35-45	21-41	24-35	1.25-1.40	0.2-2.0	0.17-0.21	3.0-5.4	0.5-2.5
	12-40	35-45	22-41	24-35	1.25-1.40	0.2-2.0	0.17-0.21	2.9-5.2	0.1-1.0
	40-60	35-45	22-41	24-35	1.25-1.40	0.2-2.0	0.17-0.21	2.9-5.1	0.1-0.5
121:									
Vitrandic Torriorthents--	0-1	90-95	0-9	1-6	1.45-1.60	20.0-99.9	0.02-0.05	0.0-0.2	0.6-1.0
	1-8	85-95	1-13	2-12	1.45-1.60	5.9-20.0	0.04-0.06	0.1-0.4	0.1-0.5
	8-60	90-95	0-9	1-16	1.45-1.60	20.0-99.9	0.02-0.04	0.0-0.3	0.1-0.5

Table 24.—Erosion Properties

(Entries under "Erosion factors" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodibility index" apply only to the surface layer)

Map unit symbol and soil name	Depth (cm)	Erosion factors Kw	Kf	T	Wind erodi-bility group	Wind erodi-bility index
100:						
Bighawk	0-5	.10	.20	5	5	56
	5-30	.10	.24			
	30-47	.05	.17			
	47-60	.10	.24			
	60-152	.05	.24			
101:						
Bighawk family, tephra	0-5	.02	.05	3	1	220
	5-21	.10	.15			
	21-32	.32	.32			
	32-74	.05	.20			
	74-117	.17	.28			
	117-142	---	---			
102:						
Chedeski, tephra	0-5	.10	.20	2	6	48
	5-33	.15	.24			
	33-69	---	---			
	69-94	---	---			
103:						
Flaco, tephra	0-3	.02	.05	2	2	134
	3-15	.17	.28			
	15-25	.20	.20			
	25-51	.10	.24			
	51-79	.15	.28			
	79-104	---	---			
104:						
Flaco, tephra	0-3	.02	.05	2	2	134
	3-18	.15	.32			
	18-25	.15	.20			
	25-46	.24	.37			
	46-79	.32	.43			
	79-104	---	---			
Lava flows, basalt.						
105:						
Flaco, tephra	0-5	.05	.05	2	1	220
	5-15	.28	.28			
	15-36	.28	.28			
	36-64	.20	.32			
	64-89	---	---			
Pocum, tephra	0-5	.05	.05	1	1	160
	5-23	.20	.32			
	23-46	.20	.37			
	46-56	---	---			
	56-64	.17	.32			
	64-89	---	---			
106:						
Gish, tephra	0-2	.02	.05	5	2	134
	2-9	.10	.15			
	9-39	.20	.20			
	39-76	.20	.20			
	76-152	.28	.28			

Table 24.—Erosion Properties—Continued

Map unit symbol and soil name	Depth (cm)	Erosion factors Kw	Kf	T	Wind erodi-bility group	Wind erodi-bility index
107:						
Ives	0-12	.20	.20	5	4L	86
	12-24	.20	.20			
	24-61	.10	.17			
	61-152	.10	.10			
Riverwash.						
108:						
Meriwhitica	0-5	.10	.20	1	3	86
	5-18	.20	.32			
	18-28	.05	.28			
	28-53	---	---			
Rock outcrop, limestone.						
109:						
Miburn, tephra	0-7	.02	.02	3	1	180
	7-26	.20	.20			
	26-58	.20	.28			
	58-114	.15	.20			
	114-152	.15	.20			
110:						
Miburn, tephra	0-26	.02	.02	3	1	180
	26-37	.15	.24			
	37-71	.10	.20			
	71-117	.10	.24			
	117-152	.05	.05			
Cambidic Haplodurids	0-18	.15	.15	5	2	134
	18-44	.32	.32			
	44-79	---	---			
	79-107	---	---			
	107-152	---	---			
111:						
Miburn tephra	0-10	.02	.02	3	1	160
	10-18	.02	.02			
	18-56	.15	.24			
	56-81	---	---			
Heiser	0-5	.02	.02	5	1	160
	5-152	.02	.02			
Lava flows, basalt.						
112:						
Moenkopie	0-4	.10	.32	1	6	48
	4-9	.20	.32			
	9-34	---	---			
Typic Haplocambids, tephra	0-7	.10	.15	3	1	160
	7-24	.15	.24			
	24-42	.15	.24			
	42-80	.17	.24			
	80-107	.10	.20			
	107-132	---	---			

Table 24.—Erosion Properties—Continued

Map unit symbol and soil name	Depth (cm)	Erosion factors Kw	Kf	T	Wind erodi-bility group	Wind erodi-bility index
113:						
Moenkopie	0-5	.10	.10	1	2	134
	5-33	.17	.24			
	33-42	---	---			
	42-67	---	---			
Rock outcrop, sandstone.						
114:						
Nalakihu	0-7	.10	.10	2	2	134
	7-17	.10	.17			
	17-42	.24	.24			
	42-67	.24	.43			
	67-92	---	---			
115:						
Peshlaki	0-3	.02	.10	1	5	56
	3-18	.05	.20			
	18-43	---	---			
Rock outcrop, limestone.						
116:						
Rock outcrop, sandstone.						
Typic Torriorthents	0-10	.15	.28	2	5	56
	10-31	.10	.37			
	31-56	---	---			
Heiser	0-26	.02	.02	5	1	180
	26-97	.02	.02			
	97-152	.02	.02			
117:						
Sandy, Typic Torriorthents	0-8	.15	.20	3	5	56
	8-48	.10	.10			
	48-63	.02	.10			
	63-120	.10	.10			
	120-145	---	---			
118:						
Shinume	0-6	.10	.17	1	5	56
	6-12	.15	.28			
	12-27	.05	.24			
	27-40	.05	.28			
	40-65	---	---			
119:						
Trachute, tephra	0-4	.10	.10	5	2	134
	4-29	.20	.20			
	29-80	.32	.32			
	80-152	.37	.37			
Lava flows, basalt.						
120:						
Tsosie, tephra	0-2	.02	.02	5	2	134
	2-18	.17	.28			
	18-30	.28	.28			
	30-102	.32	.32			
	102-152	.32	.32			

Table 24.—Erosion Properties—Continued

Map unit symbol and soil name	Depth (cm)	Erosion factors			Wind erodi- bility group	Wind erodi- bility index
		Kw	Kf	T		
121:						
Vitrandic Torriorthents	0-3	.02	.02	5	1	160
	3-20	.02	.02			
	20-152	.02	.02			

Table 25.—Total Soil Carbon

(This table displays soil organic carbon (SOC) and soil inorganic carbon (SIC) in kilograms per square meter to a depth of 2 meters or to the representative top depth of any kind of bedrock or any cemented soil horizon. SOC and SIC are reported on a volumetric whole soil basis, corrected for representative rock fragments indicated in the database. SOC is converted from horizon soil organic matter of the fraction of the soil less than 2 mm in diameter. If soil organic matter indicated in the database is NULL, SOC is assumed to be zero. SIC is converted from horizon calcium carbonate content fraction of the soil less than 2 mm in diameter. If horizon calcium carbonate indicated in the database is NULL, SIC is assumed to be zero. A weighted average of all horizons is used in the calculations. Only major components of a map unit are displayed in this table)

Map unit symbol, component name, and component percent	SOC	SIC
	kg/m^2	kg/m^2
100:		
Bighawk (100%)	2	20
101:		
Bighawk family, tephra (85%)	2	12
102:		
Chedeski, tephra (90%)	1	4
103:		
Flaco, tephra (90%)	1	18
104:		
Flaco, tephra (75%)	1	20
Lava flows, basalt (10%)	0	0
105:		
Flaco, tephra (65%)	1	20
Pocum, tephra (25%)	1	17
106:		
Gish, tephra (90%)	2	25
107:		
Ives (60%)	3	33
Riverwash (20%)	0	0
108:		
Meriwhitica (75%)	0	4
Rock outcrop, limestone (25%)	0	0
109:		
Miburn, tephra (85%)	2	10
110:		
Miburn, tephra (45%)	2	1
Cambidic Haplodurids (40%)	1	1

Table 25.—Total Soil Carbon—Continued

Map unit symbol, component name, and component percent	SOC	SIC
	kg/m^2	kg/m^2
111:		
Miburn, tephra (50%)	1	6
Heiser (35%)	3	0
Lava flows, basalt (10%)	0	0
112:		
Moenkopie (45%)	0	1
Typic Haplocambids, tephra (40%)	2	17
113:		
Moenkopie (70%)	1	1
Rock outcrop, sandstone (20%)	0	0
114:		
Nalakihu (85%)	1	11
115:		
Peshlaki (75%)	0	0
Rock outcrop, limestone (10%)	0	0
116:		
Rock outcrop, sandstone (35%)	0	0
Typic Torriorthents (30%)	0	3
Heiser (25%)	2	0
117:		
Sandy, Typic Torriorthents (100%)	2	18
118:		
Shinume (85%)	0	6
119:		
Trachute, tephra (80%)	3	39
Lava flows, basalt (10%)	0	0
120:		
Tsosie, tephra (85%)	9	7
121:		
Vitrandic Torriorthents (100%)	2	7

Table 26.—Soil Features

(See text for definitions of terms used in this table. Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Restrictive layer			Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Hardness		Uncoated steel	Concrete
		cm				
100:						
Bighawk	No restriction	---	---	Low	Moderate	Low
101:						
Bighawk family, tephra	Lithic bedrock	102-152	Indurated	Low	Moderate	Low
102:						
Chedeski, tephra	Paralithic bedrock	7-51	Weakly cemented	Moderate	Moderate	Low
	Lithic bedrock	25-102	Indurated			
103:						
Flaco, tephra	Lithic bedrock	51-152	Indurated	Moderate	Moderate	Low
104:						
Flaco, tephra	Lithic bedrock	51-102	Indurated	Moderate	Moderate	Low
105:						
Flaco, tephra	Lithic bedrock	51-152	Very strongly cemented	Moderate	Moderate	Low
Pocum, tephra	Lithic bedrock	25-102	Indurated	Moderate	Moderate	Low
	Petrocalcic	25-51	Very strongly cemented			
106:						
Gish, tephra	No restriction	---	---	Low	High	Low
107:						
Ives	No restriction	---	---	Moderate	High	Low
108:						
Meriwhitica	Lithic bedrock	9-51	Indurated	Moderate	Moderate	Low
Rock outcrop, limestone.						
109:						
Miburn, tephra	Abrupt textural change	18-51	Noncemented	Low	High	Low
110:						
Miburn, tephra	Abrupt textural change	18-51	Noncemented	Low	High	Moderate
Cambidic Haplodurids	No restriction	---	---	Low	Moderate	Moderate

Table 26.—Soil Features—Continued

Map unit symbol and soil name	Restrictive layer			Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Hardness		Uncoated steel	Concrete
		cm				
111:						
Miburn, tephra	Abrupt textural change	18-40	Noncemented	Low	High	Low
Heiser	No restriction	---	---	Low	Moderate	Low
112:						
Moenkopie	Lithic bedrock	7-51	Indurated	Moderate	Moderate	Moderate
Typic Haplocambids, tephra	Lithic bedrock	51-152	Indurated	Moderate	Moderate	Moderate
113:						
Moenkopie	Paralithic bedrock	7-41	Weakly cemented	Low	Moderate	Low
	Lithic bedrock	10-51	Indurated			
114:						
Nalakihu	Lithic bedrock	51-102	Indurated	Moderate	Moderate	Low
115:						
Peshlaki	Lithic bedrock	7-51	Indurated	Low	Moderate	Low
116:						
Typic Torriorthents	Paralithic bedrock	12-51	Weakly cemented	Moderate	Moderate	Low
Heiser	No restriction	---	---	Low	Moderate	Low
117:						
Sandy, Typic Torriorthents	No restriction	---	---	Low	Moderate	Low
118:						
Shinume	Lithic bedrock	9-49	Indurated	Moderate	Moderate	Low
119:						
Trachute, tephra	No restriction	---	---	Moderate	Moderate	Moderate
120:						
Tsosie, tephra	No restriction	---	---	Moderate	Moderate	Low
121:						
Vitrandic Torriorthents	No restriction	---	---	Low	Moderate	Low

Table 27.—Water Features

(See text for definitions of terms used in this table. Estimates of the frequency of ponding and flooding apply to the whole year rather than to individual months. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Map unit symbol and soil name	Hydrologic group	Months	Water table: Upper limit	Water table: Lower limit	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Cm	Cm	Cm				
100:									
Bighawk	A								
		Jan-Dec	---	---	---	---	None	---	None
101:									
Bighawk family, tephra	B								
		Jan-Dec	---	---	---	---	None	---	None
102:									
Chedeski, tephra	D								
		Jan-Dec	---	---	---	---	None	---	None
103:									
Flaco, tephra	C								
		Jan-Dec	---	---	---	---	None	---	None
104:									
Flaco, tephra	C								
		Jan-Dec	---	---	---	---	None	---	None
Lava flows, basalt.									
105:									
Flaco, tephra	C								
		Jan-Dec	---	---	---	---	None	---	None
Pocum, tephra	D								
		Jan-Dec	---	---	---	---	None	---	None
106:									
Gish, tephra	C								
		Jan-Dec	---	---	---	---	None	---	None
107:									
Ives	C								
		June-July	---	---	---	---	None	---	None
		August	---	---	---	---	None	Brief	Rare
		September	---	---	---	---	None	Brief	Rare
		Oct-Dec	---	---	---	---	None	---	None

Table 27.—Water Features—Continued

Map unit symbol and soil name	Hydrologic group	Months	Water table: Upper limit	Water table: Lower limit	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Cm	Cm	Cm				
107:									
Riverwash	---								
		Jan-June	---	---	---	---	None	---	None
		July	---	---	---	---	None	Very brief	Rare
		August	---	---	---	---	None	Very brief	Rare
		September	---	---	---	---	None	Very brief	Rare
		Oct-Dec	---	---	---	---	None	---	None
108:									
Meriwhitica	D								
		Jan-Dec	---	---	---	---	None	---	None
Rock outcrop, limestone.									
109:									
Miburn, tephra	B								
		Jan-Dec	---	---	---	---	None	---	None
110:									
Miburn, tephra	B								
		Jan-Dec	---	---	---	---	None	---	None
Cambidic Haplodurids	D								
		Jan-Dec	---	---	---	---	None	---	None
111:									
Miburn, tephra	C								
		Jan-Dec	---	---	---	---	None	---	None
Heiser	A								
		Jan-Dec	---	---	---	---	None	---	None
Lava flows, basalt.									
112:									
Moenkopie	D								
		Jan-Dec	---	---	---	---	None	---	None
Typic Haplocambids, tephra	B								
		Jan-Dec	---	---	---	---	None	---	None
113:									
Moenkopie	D								
		Jan-Dec	---	---	---	---	None	---	None
Rock outcrop, sandstone.									

Table 27.—Water Features—Continued

Map unit symbol and soil name	Hydro-logic group	Months	Water table: Upper limit	Water table: Lower limit	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Cm	Cm	Cm				
114:									
Nalakihu	C								
		Jan-Dec	---	---	---	---	None	---	None
115:									
Peshlaki	D								
		Jan-Dec	---	---	---	---	None	---	None
Rock outcrop, limestone.									
116:									
Rock outcrop, sandstone.									
Typic Torriorthents	D								
		Jan-Dec	---	---	---	---	None	---	None
Heiser	A								
		Jan-Dec	---	---	---	---	None	---	None
117:									
Sandy, Typic Torriorthents	B								
		Jan-Dec	---	---	---	---	None	---	None
118:									
Shinume	D								
		Jan-Dec	---	---	---	---	None	---	None
119:									
Trachute, tephra	A								
		Jan-July	---	---	---	---	None	---	None
		August	---	---	---	---	None	---	Very rare
		September	---	---	---	---	None	---	Very rare
		October	---	---	---	---	None	---	Very rare
		Nov-Dec	---	---	---	---	None	---	None
Lava flows, basalt.									
120:									
Tsosie, tephra	C								
		Jan-Dec	---	---	---	---	None	---	None
121:									
Vitrandic Torriorthents	A								
		Jan-Dec	---	---	---	---	None	---	None

Table 28.—Chemical Soil Properties

(Soils properties are measured or inferred from direct observations in the field or laboratory. Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Depth	Cation-exchange capacity	Soil reaction	Calcium carbon-ate	Gypsum	Salinity	Sodium adsorp-tion ratio
	Cm	meq/100 g	pH	Pct	Pct	mmhos/cm	
100:							
Bighawk	0-5	2.2-11.0	7.4-9.0	5-10	0-2	0.0-2.0	0-2
	5-30	7.6-16.7	7.9-9.0	5-15	0-2	0.0-2.0	0-2
	30-47	7.6-16.7	7.9-9.0	5-15	0-2	0.0-2.0	0-2
	47-60	7.6-16.7	7.9-9.0	5-15	0-2	0.0-2.0	0-2
	60-152	7.6-16.7	7.9-9.0	5-15	0-2	0.0-2.0	0-4
101:							
Bighawk family, tephra	0-5	1.2-5.5	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	5-21	1.1-5.3	7.4-8.4	2-5	0-2	0.0-2.0	0-2
	21-32	8.4-16.8	7.9-9.0	10-25	0-2	0.0-2.0	0-2
	32-74	2.8-9.4	7.9-9.0	10-20	0-2	0.0-2.0	0-2
	74-117	2.8-9.4	7.9-9.0	10-20	0-2	0.0-2.0	0-2
	117-142	---	---	---	---	---	---
102:							
Chedeski, tephra	0-5	7.1-15.1	7.9-8.4	2-5	0-2	0.0-2.0	0-2
	5-33	15.8-26.7	7.9-9.0	2-15	0-2	0.0-2.0	0-4
	33-69	---	---	---	---	---	---
	69-94	---	---	---	---	---	---
103:							
Flaco, tephra	0-3	2.9-7.3	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	3-15	6.6-14.7	7.4-8.4	0-5	0-2	0.0-2.0	0-2
	15-25	17.9-26.7	7.4-8.4	2-10	0-2	0.0-2.0	0-2
	25-51	13.8-23.3	7.9-9.0	10-25	0-2	0.0-2.0	0-2
	51-79	11.0-17.6	7.9-9.0	15-50	0-2	0.0-2.0	0-4
	79-104	---	---	---	---	---	---
104:							
Flaco, tephra	0-3	2.9-7.3	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	3-18	6.6-14.7	7.4-8.4	2-10	0-2	0.0-2.0	0-2
	18-25	17.9-26.7	7.9-9.0	5-10	0-2	0.0-2.0	0-2
	25-46	13.8-23.3	7.9-9.0	10-25	0-2	0.0-2.0	0-2
	46-79	11.0-17.6	7.9-9.0	15-40	0-2	0.0-2.0	0-4
	79-104	---	---	---	---	---	---
105:							
Flaco, tephra	0-5	2.0-4.8	7.9-8.4	0	0-2	0.0-2.0	0-2
	5-15	15.2-19.7	7.9-9.0	2-5	0-2	0.0-2.0	0-2
	15-36	15.2-24.7	7.9-9.0	15-50	0-2	0.0-2.0	0-2
	36-64	15.2-24.7	7.9-9.0	15-50	0-2	0.0-2.0	0-4
	64-89	---	---	---	---	---	---
Pocum, tephra	0-5	1.9-4.6	7.9-8.4	0-2	0-2	0.0-2.0	0-2
	5-23	6.3-16.9	7.9-9.0	2-15	0-2	0.0-2.0	0-2
	23-46	6.3-14.5	7.9-9.0	15-40	0-2	0.0-2.0	0-2
	46-56	---	---	---	---	---	---
	56-64	6.3-14.5	7.9-9.0	15-40	0-2	0.0-2.0	0-2
	64-89	---	---	---	---	---	---

Table 28.—Chemical Soil Properties—Continued

Map unit symbol and soil name	Depth	Cation-exchange capacity	Soil reaction	Calcium carbon-ate	Gypsum	Salinity	Sodium adsorp-tion ratio
	Cm	meq/100 g	pH	Pct	Pct	mmhos/cm	
106:							
Gish, tephra	0-2	1.1-3.0	7.4-8.4	0	0-2	0.0-2.0	0-2
	2-9	2.7-12.7	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	9-39	20.5-33.5	7.4-8.4	2-5	0-2	0.0-2.0	0-2
	39-76	20.5-33.5	7.9-8.4	10-15	0-2	0.0-2.0	0-2
	76-152	20.5-33.5	7.9-8.4	10-25	0-2	0.0-2.0	0-2
107:							
Ives	0-12	15.2-22.0	7.4-7.9	10-25	0-4	0.0-2.0	0-2
	12-24	6.6-16.2	7.4-7.9	10-25	0-4	0.0-2.0	0-2
	24-61	6.6-16.2	7.4-7.9	10-25	0-4	0.0-2.0	0-2
	61-152	6.6-16.2	7.4-7.9	10-15	0-4	0.0-2.0	0-2
108:							
Meriwhitica	0-5	4.7-12.8	7.9-8.4	2-10	0-2	0.0-2.0	0-2
	5-18	4.3-12.5	7.9-8.4	10-50	0-2	0.0-2.0	0-2
	18-28	4.3-8.6	7.9-8.4	10-50	0-2	0.0-2.0	0-2
	28-53	---	---	---	---	---	---
109:							
Miburn, tephra	0-7	1.0-4.7	7.4-7.8	0	0	0.0-2.0	0-2
	7-26	1.0-4.6	7.4-7.8	0	0	0.0-2.0	0-2
	26-58	3.6-11.0	7.9-9.0	0-5	0	0.0-2.0	0-2
	58-114	2.7-9.4	7.9-9.0	0-5	0-2	0.0-2.0	0-2
	114-152	2.7-9.4	7.9-9.0	0-5	0-4	0.0-2.0	0-2
110:							
Miburn, tephra	0-26	1.0-3.8	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	26-37	6.6-11.7	7.9-9.0	2-10	0-2	0.0-2.0	0-2
	37-71	2.7-7.1	7.9-9.0	0-2	0-2	0.0-4.0	0-2
	71-117	2.7-7.1	7.9-9.0	0-2	0-2	0.0-4.0	0-2
	117-152	2.7-7.1	7.9-9.0	0-2	0-2	0.0-4.0	0-2
Cambidic Haplodurids	0-18	2.1-8.2	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	18-44	2.8-6.7	7.9-9.0	0-5	0-2	0.0-4.0	0-2
	44-79	---	---	---	---	---	---
	79-107	---	---	---	---	---	---
	107-152	---	---	---	---	---	---
111:							
Miburn, tephra	0-10	1.9-5.5	7.4-7.8	0	0-2	0.0-2.0	0-2
	10-18	1.0-4.6	7.4-8.4	0	0-2	0.0-2.0	0-2
	18-56	6.6-14.0	7.9-9.0	10-25	0-2	0.0-2.0	0-2
	56-81	---	---	---	---	---	---
Heiser	0-5	0.7-2.8	6.6-7.9	0	0-2	0.0-2.0	0-2
	5-152	0.7-2.7	7.4-7.9	0	0-2	0.0-2.0	0-2
112:							
Moenkopie	0-4	13.1-21.3	7.9-9.0	10-15	0-2	0.0-4.0	0-2
	4-9	13.1-21.2	7.9-9.0	10-25	0-2	0.0-4.0	0-2
	9-34	---	---	---	---	---	---
Typic Haplocambids, tephra	0-7	3.6-8.7	7.9-8.3	0-2	0-2	0.0-2.0	0-2
	7-24	6.6-14.7	7.9-9.0	2-10	0-2	0.0-4.0	0-2
	24-42	6.6-14.7	7.9-9.0	10-25	0-2	0.0-4.0	0-2
	42-80	3.6-8.6	7.9-9.0	10-15	0-2	0.0-4.0	0-2
	80-107	3.6-8.6	7.9-9.0	10-25	0-2	0.0-4.0	0-2
	107-132	---	---	---	---	---	---

Table 28.—Chemical Soil Properties—Continued

Map unit symbol and soil name	Depth	Cation-exchange capacity	Soil reaction	Calcium carbon-ate	Gypsum	Salinity	Sodium adsorp-tion ratio
	Cm	meq/100 g	pH	Pct	Pct	mmhos/cm	
113:							
Moenkopie	0-5	2.7-8.7	7.9-8.4	1-5	0-2	0.0-2.0	0-2
	5-33	2.7-8.6	7.9-8.4	0-2	0-2	0.0-2.0	0-2
	33-42	---	---	---	---	---	---
	42-67	---	---	---	---	---	---
114:							
Nalakihu	0-7	2.7-6.3	7.9-9.0	2-5	0-2	0.0-2.0	0-2
	7-17	11.7-21.2	7.9-9.0	2-10	0-2	0.0-2.0	0-4
	17-42	13.8-21.2	7.9-9.0	10-25	0-2	0.0-2.0	0-4
	42-67	13.8-21.2	7.9-9.0	15-30	0-2	0.0-2.0	0-4
	67-92	---	---	---	---	---	---
115:							
Peshlaki	0-3	1.0-5.0	7.9-8.4	0	0-2	0.0-2.0	0-2
	3-18	2.3-6.7	7.9-8.4	0-2	0-2	0.0-2.0	0-2
	18-43	---	---	---	---	---	---
116:							
Typic Torriorthents	0-10	15.2-23.4	7.9-8.4	10-15	0-2	0.0-2.0	0-2
	10-31	19.9-26.7	7.9-8.4	10-15	0-2	0.0-2.0	0-2
	31-56	---	---	---	---	---	---
Heiser	0-26	0.7-3.9	7.4-7.9	0	0	0.0-2.0	0-2
	26-97	0.3-2.7	7.4-7.9	0	0	0.0-2.0	0-2
	97-152	0.3-2.7	7.4-7.9	0	0	0.0-2.0	0-2
117:							
Sandy, Typic Torriorthents	0-8	6.5-13.7	7.4-8.4	2-10	0-2	0.0-2.0	0-2
	8-48	1.6-6.1	7.4-8.4	2-10	0-2	0.0-2.0	0-2
	48-63	1.6-6.1	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	63-120	1.6-6.1	7.4-8.4	2-10	0-2	0.0-2.0	0-2
	120-145	---	---	---	---	---	---
118:							
Shinume	0-6	15.2-23.4	7.4-8.4	10-25	0-2	0.0-2.0	0-2
	6-12	9.6-14.7	7.9-8.4	10-25	0-2	0.0-2.0	0-2
	12-27	9.6-14.7	7.4-8.4	10-25	0-2	0.0-2.0	0-2
	27-40	9.6-14.7	7.9-8.4	10-25	0-2	0.0-2.0	0-2
	40-65	---	---	---	---	---	---
119:							
Trachute, tephra	0-4	3.6-10.3	7.9-9.0	10-25	0-2	0.0-4.0	0-4
	4-29	2.2-11.2	7.9-9.0	10-25	1-4	0.0-4.0	0-4
	29-80	3.6-14.7	7.9-9.0	10-25	1-4	0.0-4.0	0-4
	80-152	3.6-10.2	7.9-9.0	10-25	0-2	0.0-4.0	0-4
120:							
Tsosie, tephra	0-2	4.0-28.8	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	2-18	19.9-28.7	7.9-8.4	0-5	0-2	0.0-2.0	0-2
	18-30	19.0-28.5	7.9-8.4	2-15	0-2	0.0-2.0	0-2
	30-102	17.9-27.5	7.9-8.4	2-15	0-2	0.0-2.0	0-2
	102-152	17.9-26.7	7.9-8.4	2-15	0-2	0.0-2.0	0-2
121:							
Vitrandic Torriorthents	0-3	0.9-4.1	7.4-8.4	0-2	0-2	0.0-2.0	0-2
	3-20	0.7-6.7	7.9-9.0	2-5	0-2	0.0-2.0	0-2
	20-152	0.3-9.2	7.9-9.0	2-10	0-2	0.0-2.0	0-2

Table 29.—Taxonomic Classification of the Soils

Soil name	Family or higher taxonomic class
Bighawk	Ashy-skeletal, glassy, mesic Vitrandic Haplocambids
Bighawk family	Ashy-skeletal, glassy, mesic Vitrandic Haplocambids
Cambidic Haplodurids	Sandy, mixed, mesic Cambidic Haplodurids
Chedeski	Loamy, mixed, superactive, mesic, shallow Ustic Haplocambids
Flaco	Fine-loamy, mixed, superactive, mesic Ustic Calciargids
Gish	Fine, mixed, superactive, mesic Ustic Haplocambids
Heiser	Ashy, glassy, nonacid, mesic Vitrandic Torripsamments
Ives	Coarse-loamy, mixed, superactive, calcareous, mesic Typic Torrifluvents
Meriwhitica	Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents
Miburn	Ashy over loamy, glassy over mixed, superactive, nonacid, mesic Vitrandic Torriorthents
Miburn family	Ashy over loamy, glassy over mixed, superactive, nonacid, mesic Vitrandic Torriorthents
Moenkopie	Loamy, mixed, superactive, calcareous, mesic Lithic Torriorthents
Nalakihu	Fine-loamy, mixed, superactive, mesic Vitrandic Haplocalcids
Peshlaki	Ashy-skeletal, glassy, nonacid, mesic Lithic Ustic Torriorthents
Pocum	Loamy, mixed, superactive, mesic, shallow Calcic Petrocalcids
Sandy, Typic Torriorthents	Sandy, mixed, mesic Typic Torriorthents
Shinume	Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Torriorthents
Trachute	Coarse-loamy, mixed, superactive, calcareous, mesic Typic Torriorthents
Tsosie	Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torriorthents
Typic Haplocambids	Coarse-loamy, mixed, superactive, mesic Typic Haplocambids
Typic Torriorthents	Typic Torriorthents
Vitrandic Torriorthents	Cindery, glassy, calcareous, mesic Vitrandic Torriorthents

Table 30.—Soil Classification Key

ORDER / Suborder / Great Group / Subgroup / Series or Higher Category	
ARIDISOLS	
Argids	
Calciargids	
Ustic Calciargids	
Flaco	Fine-loamy, mixed, superactive, mesic Ustic Calciargids
Durids	
Haplodurids	
Cambidic Haplodurids	
Cambidic Haplodurids	Sandy, mixed, mesic Cambidic Haplodurids
Calcids	
Haplocalcids	
Vitrandic Haplocalcids	
Nalakihu	Fine-loamy, mixed, superactive, mesic Vitrandic Haplocalcids
Petrocalcids	
Calcic Petrocalcids	
Pocum	Loamy, mixed, superactive, mesic, shallow Calcic Petrocalcids
Cambids	
Haplocambids	
Vitrandic Haplocambids	
Bighawk	Ashy-skeletal, glassy, mesic Vitrandic Haplocambids
Bighawk family	Ashy-skeletal, glassy, mesic Vitrandic Haplocambids
Ustic Haplocambids	
Gish	Fine, mixed, superactive, mesic Ustic Haplocambids
Chedeski	Loamy, mixed, superactive, mesic, shallow Ustic Haplocambids
Typic Haplocambids	
Typic Haplocambids	Coarse-loamy, mixed, superactive, mesic Typic Haplocambids

Table 30.—Soil Classification Key—Continued

ORDER Suborder Great Group Subgroup Series or Higher Category	
ENTISOLS	
Fluvents	
Torrifluvents	
Typic Torrifluvents	
Ives	Coarse-loamy, mixed, superactive, calcareous, mesic Typic Torrifluvents
Orthents	
Torriorthents	
Typic Torriorthents	
Trachute	Coarse-loamy, mixed, superactive, calcareous, mesic Typic Torriorthents
Sandy, Typic Torriorthents	Sandy, mixed, mesic Typic Torriorthents
Typic Torriorthents	Typic Torriorthents
Lithic Torriorthents	
Moenkopie	Loamy, mixed, superactive, calcareous, mesic Lithic Torriorthents
Shinume	Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Torriorthents
Lithic Ustic Torriorthents	
Peshlaki	Ashy-skeletal, glassy, nonacid, mesic Lithic Ustic Torriorthents
Meriwhitica	Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents
Ustic Torriorthents	
Tsosie	Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torriorthents
Vitrandic Torriorthents	
Miburn	Ashy over loamy, glassy over mixed, superactive, nonacid, mesic Vitrandic Torriorthents
Miburn family	Ashy over loamy, glassy over mixed, superactive, nonacid, mesic Vitrandic Torriorthents
Vitrandic Torriorthents	Cindery, glassy, calcareous, mesic Vitrandic Torriorthents
Psamments	
Torripsamments	
Vitrandic Torripsamments	
Heiser	Ashy, glassy, nonacid, mesic Vitrandic Torripsamments

Table 31.—Lab-Sampled Pedons

(KSSL represents the Kellogg Soil Survey Laboratory in Lincoln, Nebraska)

Correlated name	Pedon type	Sampled as name	User site ID	Lab source	Lab pedon number
Bighawk	Modal pedon for series	Vitrandic Haplocambids	S2012AZ005004	KSSL	12N7969
Cambidic Haplodurids	Modal pedon for series	Typic Haplodurids	S2012AZ005002	KSSL	12N7967
Flaco	Modal pedon for series	Vitrandic Haplocalcids	S2012AZ005003	KSSL	12N7968
Flaco	Modal pedon for series	Bighams	S2012AZ005005	KSSL	12N7970
Miburn	Correlates to named soil	Vitrandic Torripsamments	S2012AZ005006	KSSL	127971
Tsosie	Modal pedon for series	Ralphston	S2012AZ005007	KSSL	12N7972

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