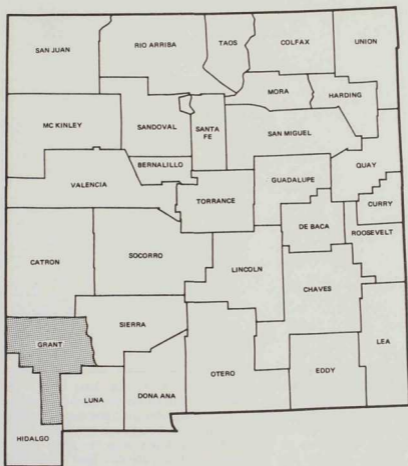


SOIL ASSOCIATIONS AND
LAND CLASSIFICATION FOR IRRIGATION
GRANT COUNTY

*Agricultural Experiment Station
in cooperation with
Water Resources Research Institute
and
Soil Conservation Service*



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ASSOCIATIONS AND
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Summary

Grant County has a total land area of about 2,540,800 acres. Approximately 22 percent of this, or about 569,600 acres, is considered suitable for irrigation. Of this total estimated acreage of irrigable land, about 5,700 acres are now irrigated. Therefore, a large acreage of land remains that is suitable for irrigation. The potential for expanding irrigation is limited by a lack of water and by economic restrictions rather than by a shortage of suitable soils. Of the land classified as suitable for irrigation, approximately 86,827 acres are in irrigation land class 1; 147,793 acres in class 2; 248,867 acres in class 3; and 86,108 acres in class 4. The remaining 1,971,205 acres in the county are in land class 6, which is not suitable for irrigation.

The data are organized and presented on the basis of the 17 soil associations shown on the general soil map (see figure 1). The irrigation land classification map (figure 2) shows the approximate distribution of irrigation land classes in Grant County. Only the dominant land classes are shown in each of the areas outlined.

The soil associations differ significantly in suitability for other uses just as they do in suitability for irrigation. For example, the use of land in the Stony Rockland association (No. 15) is generally restricted to recreation, grazing and habitat for wildlife, and limited grazing for livestock. In contrast, the Mohave-Stellar association (No. 3) is suitable for many uses, including irrigated farming, range, urban and industrial sites, recreation, and wildlife habitat. The high mountainous land in soil associations 16 and 17 includes the principal timber producing soils in the area. These associations also provide some grazing and a good habitat for many species of wildlife, and offer many recreational opportunities.

The soils were also classified in the American Association of State Highway Officials (AASHO) and Unified systems to facilitate use of the soil association information by engineers and others acquainted with these groupings. Information relative to the suitability of the soils for a variety of engineering uses and specific factors limiting their use are also given in the engineering section.

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SOIL ASSOCIATIONS AND LAND CLASSIFICATION FOR IRRIGATION GRANT COUNTY

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An essential for planning the best possible use of land and water resources is information on the capability of soils for many uses, present and potential. One such land use is irrigated agriculture, and the many soils occurring within New Mexico should be evaluated for this land use, especially since there is interest in the expansion of irrigation in the state. The water required for the new irrigated land, if expansion should occur, would be developed locally, transferred from other sections of the state, or brought in from distant sources.

The primary purpose of this report is to present information on the suitability of soils in Grant County for irrigation. The acreage, general location, and relative capability of the soils for such use are given. This information can be used in appraising the value or suitability of large tracts of land for irrigation. Only soils capable of high productivity under sustained irrigation can be expected to provide a satisfactory income for farm operators. Obviously, limited or expensive irrigation water should be used on soils that are the most productive and have the fewest limitations.

The extent, location, and relative suitability of land for irrigation in Grant County are presented in the map showing land classification for irrigation (see figure 2). The general soils map (figure 1) based on a reconnaissance soils survey provided the information needed for the classification for irrigation.

The general soil map is also useful in community or broad area planning. It provides information on soil resources of large tracts that can be used for preliminary planning for irrigated agriculture, forestry, range, urban, engineering, recreation, and wildlife uses, and it shows the general location of soils that will present problems in the construction of roads or building foundations.

The general soil map of Grant County does not replace the need for detailed soil maps for operational planning on individual farms and ranches or the planning of specific locations for houses, roads, parks, and other items of this nature. General soil maps are suitable *only for general or broad area planning*. They can, however, serve a very useful purpose in the planning process.

Procedures

In this county, the irrigation land classes were assigned primarily on the basis of the soil data available from the general soil map (figure 1). Although such general soil maps are often made by generalizing from large-scale detailed soil maps, this was possible only to a limited extent in Grant County. Detailed soil surveys were limited to the irrigated lands and small areas of rangeland where

special studies were conducted. The general soil map of this county, therefore, was prepared to a large extent on the basis of a field reconnaissance

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together with interpretation of airphotos, topographic maps, geological maps, and other available information.

When detailed soil surveys are completed for the entire area, some of the soil names that are used to identify the soil associations may be changed. This will not affect the usefulness of the map, however, because the names only identify the mapping units. The soil properties and qualities of the soils comprising the mapping units will not change.

The general soil map (figure 1) was prepared by grouping geographically associated soils into 17 general soil areas. These units, referred to as "soil associations," are landscapes, or geographic areas, that have distinctive proportional patterns of soils. Each kind of soil normally occurs in a comparatively small area, so the units on the general soil map of Grant County consist of two or more kinds of soil. In addition, land types and a number of less extensive soils are commonly components of the map units in this county. The kinds of soil included in each soil association are not necessarily similar. In fact, they often have contrasting characteristics that influence their use and management.

In the classification of soils for irrigation, the major soils and miscellaneous land types within each soil association were placed into one of five classes of land, depending upon their suitability for irrigated agriculture (table 5). The criteria used in the placement of soils in the irrigation land classes are those proposed at the 1967 conference organized by the Federal Water Resources Council³, as modified by a committee of this conference on January 12, 1968. These criteria were agreed upon by authorities from several organizations concerned with land classification and appear to have a particularly high reliability. For uniform and consistent application of these criteria and standards, the New Mexico Soils Work Group have issued guidelines and clarifications as needed and appropriate.

The classification system establishes four classes of irrigable land and one class of non-irrigable land. The limitations for use under irrigation increase from class 1 through 4. For example, class 1 has few or no limitations for use as cropland under irrigation. It is productive and well adapted to irrigation. High yields of most climatically adapted crops can be obtained on this land with good management. Class 2 land, although well suited to irrigation, has slight to moderate limitations for sustained use under irrigation. This is moderately

productive land, or land that requires more than average management to obtain high yields of climatically adapted crops. Class 3 land, which has moderate to severe limitations for sustained use under irrigation, is generally not as suitable for the production of as wide a range of the climatically adapted crops as land in classes 1 and 2. This land also has a more limited productivity for many of the climatically adapted crops, or requires a very high level of management to obtain moderate to high yields. Class 4 land has a very severe limitation for sustained use under irrigation. The land included in this class is usually suited only to a relatively few of the climatically adapted crops. Some of this land may be adapted or used for the production of specialized crops under a very high level of management. Class 6 land is not suitable for irrigation.

The land in Grant County was placed in the various irrigation land classes on the basis of soil properties and qualities that affect their suitability for continued use under irrigation. Neither the availability of irrigation water nor the cost of pumping and conveying it enters into the classification, nor was the shape, size, or location of lands with respect to other lands to be developed for irrigation considered in this classification. The detailed criteria used in the placement of land in the various irrigation land classes are listed in table 1.

The factors that affected the placement of land in the various irrigation land classes were: soil texture, effective soil depth, available water-holding capacity, permeability, salinity, alkali, surface smoothness, slope, erosion, internal soil drainage, and surface drainage. For example, the Nickel and Upton soils were classed as non-irrigable because of their limited thickness of effective soil and very low moisture-retention capacity. The Hondale soils, although deep and of high water-holding capacity, were placed in irrigation land class 4 because of their fine texture, very slowly permeable subsoil, and a moderate to high content of alkali or exchangeable sodium. The soils of the Sonoita-Yturbide-Hap association are dominantly in class 3 because of their sandy and gravelly textures and low moisture-retention capacity. In the northern and mountainous parts of the county steep slopes and rough broken topography together with stone and gravel content and limited water-holding capacity were the principal factors contributing to the placement of much of the land in class 6. This is in contrast to the land in the Mohave-Stellar association which is dominated by land in classes 1 and 2 because of favorable soil properties and related land factors.

³Proceedings of Water Resources Council, Irrigation Land Classification Seminar, Salt Lake City, Utah, July 1967.

Table 1. Land classification specifications for Pacific Southwest Basin irrigation land classes¹

Land Characteristics	Class 1	Class 2	Class 3	Class 4	Non-irrigable Class 6
Soils					
Texture (Surface 12") ²	LVFS-CL	LS-C Peat, Muck	MS-C	MS-C	All other lands not meeting criteria for arability
Moisture Retention (AWHC-48") ³	> 6.0"	4.5" 6.0"	3.0" 4.5"	2.5" 3.0"	
Effective Depth (inches)	> 40" ⁴	30-40	20-30	10-20	
Salinity (EC _e x 10 ³ - equil.)	< 4	4-8	8-12	12-16	
Sodic Conditions⁵					
Percent area affected	< 5	5-15	15-25	25-35	
Severity of problem ⁶	Slight	Moderate	Moderate	Moderate	
Permeability (in place - in/hr)	0.2-5.0	0.05-5.0	0.05-10.0	Any	
Permissible coarse fragments (% by vol.)					
Gravel	15	35	55	70	
Cobbles	5	10	15 ⁷	35 ⁷	
Rock Outcrops (distance apart in feet)	200	100	50	30	
Soil Erosion (for all classes)	Severely eroded soils will be downgraded one class. Less severely eroded soils may be downgraded one class, depending on other conditions.				
Topography (or land development items)⁸					
Stone for Removal (cubic yards per acre)	10	25	50	70	
Slope (percent)					
Moderately to severely erodible	< 2	2-5	5-10	10-20	
Slightly erodible	< 4	4-10	10-20	20-25	
Surface Leveling or Tree Removal (amount of cover)					
	Light	Medium	Medium heavy	Medium heavy	
Irrigation Method					
	Lands unsuited to gravity irrigation where land grading would permanently reduce soil fertility below arable limits or exceed permissible costs, or field pattern too complex, may be considered for sprinkler. Land must meet other requirements for arability. Designate by "S" - example, 3-S.				
Drainage					
Soil Wetness (depth to water table during growing season with or without drainage)					
Loam or finer	> 60"	40"-60"	20"-40"	10"-20"	
Sandy	> 50"	30"-50"	20"-30"	10"-20"	
Surface Drainage	Good	Good	Restricted	Restricted	
Depth to Drainage Barrier (in feet)	> 7	6-7	5-6	1.5-5	
Air Drainage ⁹	No Problem	Minor	Restricted	Restricted	

¹Specifications are representative of conditions after land is developed for irrigation. Each individual factor represents a minimum requirement, and unless all other factors are near optimum two or more interacting deficiencies may result in land being placed in lower class or designated class 6 -- non-irrigable.

²Finer textures may be required than those indicated for each class in areas subject to critical hot spells or wind; coarser textures may sometimes be permissible.

³In areas of very warm growing season 3" may be required for class 4 and in cold areas as little as 5" may be permitted for class 1.

⁴Depth of 60" or more is required for class 1 where deep-rooted crops are important.

⁵More extensive and severe sodic problems may be tolerated in areas of wide crop adaptability.

⁶Severity of problem: **Slight** - ESP less than 15% or less than 25% if dominated by nonswelling clays; **moderate** - ESP less than 20% or less than 30% if clay minerals favorable; **severe** - ESP less than 30%; with certain soil minerals may range above 50% as measured by usual techniques.

⁷May range above 50% in subsoil for certain crops if surface soil is favorable.

⁸Special crop and management practices may justify exceeding the limits for stone removal or slope in class 4; irregularity of slope may necessitate downgrading of class unless deficiency is compensated for by possibility of sprinkler irrigation.

⁹Air drainage is a consideration mainly in areas adapted to fruit or to early or late vegetables.

Abbreviations:

LVFS - loamy very fine sand
LS - loamy sand
MS - medium sand

CL - clay loam
C - clay
AWHC - available water holding capacity
ESP - exchangeable sodium percentage

Description of the Area

Location and Topography

Grant County, comprising an area of about 3,970 square miles, or 2,540,800 acres, is located in the southwestern part of New Mexico. Arizona forms the north part of its western boundary, and the crests of the Black and Mimbres mountain ranges form the north part of its eastern boundary. A panhandle extension of this country, which is approximately 18 miles wide and 45 miles long, extends south between Hidalgo County to the west and Luna County to the east.

Within Grant County, there is a great variety of physical resources and landscapes. The northern part is a high mountainous and wooded area with elevations ranging from about 6,500 in the foothill areas to nearly 11,000 feet on some of the higher mountain peaks. The elevations in much of this mountainous area, however, range between 7,000 and 8,500 feet. Although topography varies extremely, much of this area is characterized by a rough and broken type of topography, including steep and very steep mountain slopes and canyons. Intermingled with the steep and very steep mountainous areas are gently to strongly sloping narrow valley bottoms and gently sloping and rolling uplands and ridge tops. The mountainous foothill areas, which are also extensive in this county, are dominated by rolling to hilly and moderately steep topography. Similar gently sloping narrow valley bottoms and steep canyon walls and escarpments also occur in the foothill areas.

The southern part of the county consists generally of a broad, nearly level to gently sloping, semi-desert plain from which rise relatively narrow but steep and rugged mountain ridges, isolated peaks, and ranges of hills. Except for the mountains and hills, the plains area conveniently divides into two physiographic areas—the piedmont slopes surrounding the mountains and the basin floors. The piedmont slopes typically grade from the base of the mountainous areas towards the nearly level floors of the broad intermontane basins. The upper piedmont slopes, which are commonly dissected by ephemeral streams originating in the associated mountainous areas, are moderately to strongly sloping. Away from the mountain fronts, the lower piedmont slopes are characterized by broad and relatively smooth surfaces with gradients that range from nearly level to very gently sloping.

The nearly level to very gently sloping basin floors occupy the lower lying landscapes in this

county. The elevation in this part of the county is near 4,000 feet.

The Gila River, which flows through the north-west part of the county in a general northeast to southwest direction, is the major stream in the area. Essentially all surface runoff from the northwestern part of the county enters the Gila River drainage system. Most of the drainage in the remaining parts of the county is into closed basins. This includes the Mimbres River, which originates in and drains and extensive area in the northeastern part of the county. It flows south into Luna County, which is part of a large closed-basin complex that eventually drains into the play region of northern Chihuahua in Mexico.

Climate⁴

Average annual precipitation ranges from 8 to 10 inches in the panhandle area of the south to more than 25 inches in the northern and eastern mountains.

Summer is the rainy season, when moist air from over the Gulf of Mexico enters western New Mexico in the general circulation about the Bermuda high pressure area which has been displaced to the west. Approximately half the average annual precipitation falls from July through September, mostly from brief but intense afternoon thunderstorms. Except for small areas east of the Continental Divide, there is an increase in precipitation in winter months as a result of moist Pacific Ocean air which reaches New Mexico in the general circulation from the west.

Occasionally, tropical storms in the Gulf of California cause heavy rains and local flooding in southwestern New Mexico river basins.

In the lower elevations, an average of 20 days a year have precipitation of 0.10 inch or more; in the middle elevations, the average is nearly 30 days; and in the mountains, it is over 40 days. An average of four to eight days a year receive 0.50 inch or more precipitation, the number generally increasing with increase in elevation. Much of the winter precipitation in the higher elevations is in the form of snow, falling mostly in the period December through March. Lower elevations average from one to four inches of snow a season, the middle elevations a foot or more, and the higher mountains may accumulate depths of four

⁴This section was prepared by Frank E. Houghton, ESSA, Weather Bureau State Climatologist.

to five feet. In the lower elevations, snow seldom remains long on the ground.

Mean annual temperature ranges from 60 degrees in the south and lower elevations to nearly 56 degrees in mid-elevations, and to less than 50 degrees in the highest mountains.

Annual precipitation and temperature patterns for Fort Bayard are shown in table 2, and these patterns are generally representative of other county locations. Selected climatological data for county localities are shown in table 3 for comparison.

Most localities except the mountains have had extreme temperatures of more than 100 degrees; 108 degrees at Hachita and 10 miles southeast of Cliff. Extreme low temperature is 12 degrees below

zero at Fort Bayard and Silver City. Most nights from November through March have freezing temperatures. The average freeze-free season is May through October, six months, at most localities below 6,500 feet elevation.

Annual evaporation, as estimated from a Class A pan, averages 90 inches in the county, about 60 inches of which occurs during the freeze-free season. Sunshine averages about 3,600 hours a year, or approximately 70 percent of the possible number of hours.

Relative humidity average nearly 55 percent for the year, with early morning humidity about 30 percent. Relative humidity is a little lower in the spring and fall than in summer and winter.

Table 2. Monthly temperatures and precipitation, Fort Bayard, Grant County, New Mexico, for period of record through 1960, except as indicated

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperatures (F°)												
Average daily maximum	52	55	60	69	77	87	86	85	80	71	60	53
Average daily minimum	25	27	31	37	44	54	58	57	52	42	31	26
Daily mean	39	41	46	53	61	70	72	71	68	56	46	39
Extreme maximum	76	80	85	91	99	105	104	102	100	90	81	73
Extreme minimum	-12	-6	8	13	25	33	44	44	29	19	-1	-3
Precipitation												
Average (inches)	.85	.96	.75	.38	.39	.73	3.10	3.34	2.02	1.15	.71	.90
Average days 0.10 inch or more (no.)*	3	2	3	1	1	1	7	8	2	4	1	2
Average snowfall (inches)	4.0	3.9	2.6	0.3	T	0	0	0	0	0.1	1.0	3.2

*Period of record 1954-1960, only
T = Trace, less than 0.05 inch

Table 3. Annual averages of selected climatological data, Grant County, New Mexico, for the period of record through 1960, except as indicated

Station	Elevation feet	Temperatures			Precipitation		Last 32°F or Lower in Spring	First 32°F or Lower in Fall	Time Between Dates
		Mean maximum F°	Mean minimum F°	Yrs. of record no.	Mean annual in.	Yrs. of record no.			
Cliff (10 mi. SE)	4,900	75	38	13	12.16	17	May 10	Oct. 18	161
Fort Bayard	6,152	70	40	59	15.28	92	April 27	Oct. 24	180
Hachita	4,504	76	43	26	10.12	52	April 10	Nov. 5	209
Santa Rita*	6,312	69	44	21	16.84	21	April 15	Nov. 2	201
Silver City	5,895	68	40	27	16.38	58	April 27	Oct. 25	181
Buckhorn	4,900				12.07	14			
Cureton Ranch	5,200				12.14	21			
Mimbres Ranger Station	6,247				17.11	47			
Pinos Altos	7,000				21.29	49			
Red Rock	4,150				12.09	52			
White Signal	6,070				12.98	12			
Whitewater	5,150				8.74	12			
McKnight#	9,580				25.00	11			

*Period of record 1931-1952

#Storage-gage, period of record 1964-1965

Land Use

The general area now included in Grant County was inhabited by Apache Indians during the periods of Spanish-Mexican and early Anglo settlement of New Mexico. It is reported that the Indians were hostile, and this undoubtedly acted as a deterrent to non-Indian settlement until the late 1800's.⁵

Silver City, the largest city in Grant County, has been closely associated with the county's history and development. The city was founded in 1870 and has served as the county seat of Grant County since 1874. During this period and the years immediately following, Silver City developed as the center of mining activity in this area. Mining activities stimulated ranching and farming, and, with the increase and growth of these agricultural enterprises, Silver City became the principal trade center for ranchers and farmers in Grant County.⁵

The early settlement in Grant County, however, was not far from Cliff, close to a military post (Fort West) established by the U.S. Cavalry in 1860. Soldiers from Fort West probably initiated irrigation in Grant County by diverting water from the Gila River to irrigate pastures for their horses. By 1875, the early settlers in the vicinity of the military post had established other ditch systems, and soon thereafter irrigation was being practiced in other sections of Grant County where water and land were available.⁵

Although only about 9,130 acres are farmed under irrigation, it is an important agricultural enterprise.⁶ Alfalfa and other irrigated hay and pasture crops are grown most extensively. A number of other crops are also grown, but many are of a very limited acreage. These include small grains, corn, grain and forage sorghums, cotton, orchards, and vegetable crops.

A large percentage of the land in Grant County is used for grazing of livestock. Ranching, therefore, remains the principal agricultural enterprise, and in 1969 there were approximately 50,000 head of cattle on the farms and ranches in this county.⁷

The use of land for mining, forestry, wildlife, and recreational purposes is also important in this

county. Soil associations 16 and 17 (figure 1) in particular support fair to good stands of timber. All the high mountainous areas and adjacent foothills provide good habitat for many species of wildlife. These areas also offer many opportunities for outdoor recreation, including camping, fishing, hunting, and other activities of similar nature.

The present use of the land in each soil association is shown in the following list. A land use is shown only when it appears to apply to at least 1 percent of the association. Although much of the land is used for recreation, this is not included because of the difficulty of accurately determining its extent.

<i>Soil Map Symbol and Soil Association</i>	<i>Present Land Use</i>
1. Hondale-Mimbres	Range
2. Mimbres-Verhalen	Irrigated farming; range
3. Mohave-Stellar	Range
4. Sonoita-Yturbide-Hap	Range
5. Nickel-Upton-Tres Hermanos	Range
6. Eba	Range
7. Rockland-Lehmans	Range
8. Lonti-Poley-Pastura	Range
9. Rough Broken Land-Lonti	Range
10. Lonti-Rough Broken Land	Range
11. Luzena-Arp	Range
12. Cabezon-Thunderbird	Range
13. San Mateo-Shanta	Irrigated farming; range
14. Rockland-Luzena-Santana	Range
15. Stony Rockland	Range
16. Capillo-Tampico	Forestry; range
17. Capillo-Raton-Weed	Forestry; range

⁵Water Resources of New Mexico; State Planning Office, Santa Fe, New Mexico, 1967.

⁶New Mexico Soil and Water Conservation Needs Inventory, Statistical Report, Soil Conservation Service and other Federal and State Agencies, 1970.

⁷New Mexico Agricultural Statistics, Vol. VI. Supplement II, 1969.

Seventeen soil associations are shown in figure 1. Each of these 17 general soil areas, or soil associations, includes soils that are geographically associated and comprise recognizable landscapes. The soil associations are named for the major soil series and land types that occur within them. In addition to the named soils, the associations often contain soils of other series. Selected soil characteristics and qualities of major soils in each soil association are summarized in table 4. A description of each of the soil associations follows:

1. Hondale-Mimbres association

Included in this association are broad, nearly level to very gently sloping basin floors and valley bottoms. This unit, which comprises an area of about 13,055 acres in the southern part of the county, includes the lowest lands in Grant County. Elevations are mainly between 4,200 and 4,400 feet. Although drainage is into this association from surrounding lands, the surface pattern is poorly developed. The land surface is nearly level and generally undivided except for a few scattered shallow arroyo channels. The only significant difference in local relief consists of slightly elevated ridges of sandy and gravelly soils. These are commonly one to three feet higher than the surrounding surfaces.

The soils, which are deep, are developing in basin-fill sediments of mixed origin. Many of the soils in this association in their early stages of development were subject to accumulation of soluble salts and alkali because of unfavorable drainage conditions. Although they are now generally well drained, a high percentage of the soils in this unit have a moderate to high content of exchangeable sodium.

The soils of this association, which are used principally as range, support a sparse to moderate cover of vegetation. Alkali sacaton, tobosa, vine mesquite, burrograss, and saltgrass are the principal grasses. The more common shrubs are mesquite, desert saltbush, chamiza, shadscale, tarbush, rabbitbrush, and iodine bush. The intermingled "slick spots" that have surface layers high in exchangeable sodium support little or no vegetation.

Soil Characteristics. Hondale soils, the most extensive in the association, have a light brownish-gray calcareous silt loam or silty clay loam surface layer over a thick light brown clay subsoil. This is underlain by light gray weakly stratified sandy

loams, sandy clay loams, and clay loams. These soils, which are strongly alkaline, usually have moderate amounts of exchangeable sodium or alkali in the subsoil. Also occurring in close association with the normal Hondale soils are "slick spots" that are strongly alkali-affected. These soils, in addition to having a higher content of exchangeable sodium, are usually also alkali-affected in the surface layers. "Slick spots" are devoid of vegetation.

Mimbres soils in this association have a moderately thick surface layer of light brownish-gray silty clay loam or loam over a thick subsoil of pale brown silty clay loam or clay loam. The substratum, to a depth of five feet or more, consists of weakly stratified loams, sandy clay loams, and clay loams. The Mimbres soils in this unit commonly contain a moderate to high content of exchangeable sodium, with the maximum amounts typically occurring in the subsoil and substratum.

In addition to the major soils, approximately 20 percent of this association consists of a number of less extensive soils. The principal ones are those of the Maricopa, Berino, Pintura, and Simona series. The Maricopa soils have a brown sandy loam surface layer and subsoil about two feet thick over a gravelly loamy sand. The Berino and Pintura soils occur as a complex in this unit. The deep sand soils of the Pintura series occur on the coppice dunes, while the Berino soils occupy the interdune areas. The Berino soils usually have a loamy sand surface layer over a moderately permeable sandy clay loam subsoil. The Simona soils are shallow over strongly cemented caliche.

Irrigation Potential. The wide distribution and common occurrence of moderately to strongly alkali-affected soils will tend to limit the expansion of irrigated land in this association. This was the dominant factor contributing to the classification of 61 percent of the land in this association in class 4; 9 percent in class 6; and 30 percent in class 3. Soils classified as suitable for irrigation will require reclamation and a high level of management if they are to be successfully used for irrigation.

2. Mimbres-Verhalen association

This association includes four widely separated areas in the southern and southeastern parts of the county. It occupies nearly level to very gently sloping valley bottoms and basin floors that are commonly contiguous to intermittent drainages.

The soils, which are dominantly moderately fine and fine-textured, are developing in alluvial sediments of mixed origin. The association is not extensive, as it comprises an area of only about 15,815 acres, less than one percent of the county.

The soils of this association are used for grazing livestock and wildlife. Although this unit supports a variety of native grasses and shrubs, tobosa grass and vine mesquite are by far the dominant species. Due to runoff received from surrounding areas during heavy rains, moderate yields of forage are obtained under good management. In addition to the range use, a few small tracts adjacent to the Mimbres River are used as irrigated cropland.

Soil Characteristics. Mimbres soils have a moderately thick surface layer of light brownish-gray noncalcareous silty clay loam over a thick subsoil of light brown silty clay loam or clay loam. This is underlain to a depth of five feet or more by weakly stratified loams, sandy clay loams, and silty clay loams. A few fine threads and small soft masses of lime are commonly present in the lower part of the subsoil and substratum.

Vehalen soils, the other major component of this association, differ from the Mimbres soils in that they are fine-textured and very slowly permeable. These soils have a surface layer of light brownish-gray or brown noncalcareous silty clay loam. The subsoil is a brown clay or silty clay. The substratum below an average depth of about four feet is commonly stratified and many contain strata of coarser-textured materials.



Fig. 3. Typical landscape in the Mohave-Stellar association. The Mohave soils shown in the foreground are well suited to irrigation.

Also in this association are small areas of alluvial land, arroyo bottoms, as well as soils in the Arizo, Vinton, Stellar, and Mohave series. These inclusions comprise about 15 percent of the association.

Irrigation Potential. Although this is a relatively small unit, it has a fair to good potential for irrigation. Approximately 48 percent of the land in this association is in class 2; 40 percent in class 3; 8 percent in class 4; and 4 percent in class 6. The fine-textured and very slowly permeable soils, although suitable for irrigation, will require a high level of management to prevent accumulation of salts and development of unfavorable drainage conditions. In addition, much of the land in this unit will require protection from overflow or runoff from higher lying lands if developed for irrigation.

3. Mohave-Stellar association

This association, which is extensive in the panhandle or southern part of the county, comprises an area of about 191,710 acres, or 8 percent of the county. It occupies the lower parts of the piedmont slopes or plains between the desert mountains and the nearly level basin floors. These nearly level to gently sloping soils are forming in old valley filling sediments dominated by materials of acid igneous origin.

Except for a few scattered tracts of irrigated land, this association is used for grazing of livestock and wildlife. Under good management, and in years of average or above average precipitation, fair yields of forage are obtained. The extensive areas of medium-textured soils, such as Mohave sandy clay loam, support a fair cover of black grama, tobosa, Arizona cottontop, sand dropseed, burrograss, three-awns, and some creosotebush, mesquite, and tarbush. Vegetation on the moderately fine-textured soils is dominated by tobosa grass, burrograss, three-awns, and winterfat. The native vegetation on the sandy soil areas consists of a mixture of grasses, principally black grama, bush muhly, dropseeds, three-awns, tobosa, and blue grama. Shrubs and perennial forbs are represented by yucca, broom snakeweed, mormon tea, mesquite, sandsage, and wolfberry.

Soil Characteristics. The Mohave soils, one of the more extensive soils in this association, commonly occur on gently sloping piedmont surfaces. They have a thin surface layer of reddish-brown noncalcareous sandy clay loam. Their subsoil is a reddish-brown clay loam that usually

contains a few prominent streaks and soft masses of lime in the lower part. This is underlain by a light reddish-brown sandy clay loam or sandy loam with calcium carbonate occurring in finely divided forms and as thin seams and streaks. The substratum may also be gravelly at depths of four to six feet.

Stellar soils occur on the nearly level to gently sloping areas in close association with those of the Mohave series. They have a thin surface layer of pinkish-gray noncalcareous sandy clay loam or silty clay loam. This is underlain by a thick reddish-brown clay subsoil that typically contains seams and soft masses of lime in the lower part. The substratum is a light reddish-brown clay loam or gravelly clay loam with visible calcium carbonate occurring in finely divided forms and as small soft masses and seams.

Berino soils, although not one of the major soils, comprise about five percent of this association. These soils differ from the Mohave soils in that they have coarser-textured and more permeable subsoils. They have a thin surface layer of brown to reddish-brown noncalcareous sandy loam or loamy sand over a thick reddish-brown sandy clay loam subsoil. The lower part of the subsoil, which is normally calcareous, contains a few filaments and small soft masses of lime. This is underlain at depths of three to four feet by soft caliche or a pinkish-white sandy clay loam with a very high lime content. Forrest soils also account for about five percent of this association. These soils, which are moderately deep over a very gravelly clay loam high in lime, have a reddish-brown gravelly clay loam surface layer and a gravelly clay subsoil.

The remaining 35 percent of this association is composed of a relatively large number of soils, none of which are very extensive. Among the more common of these are the deep sandy soils of the Onite and Bluepoint series, the deep fine-textured soils of the Verhalen series, and the deep gravelly soils of the Sonoita series. Still less extensive soils include those of the Mimbres, Arizo, Vinton, Dona Ana, and Turney series.

Irrigation Potential. This association has the best potential in the county for expansion of irrigation. A very high percentage of the soils are well suited for use as cropland under irrigation. About 34 percent of the land in this general soil area is in class 1; 31 percent in class 2; 25 percent in class 3; 3 percent in class 4; and only 7 percent is nonirrigable or in land class 6. With leveling, irrigation systems, and good farming practices, the land in this unit has sufficient productive capacity to support sustained irrigation.

4. Sonoita-Yturbide-Hap association

This association, which includes an area of 59,230 acres, commonly occurs on gently to strongly sloping and undulating piedmont slopes at the base of mountain fronts. Slope gradients are dominantly less than five percent, but they may range up to 10 percent near the base of the mountains in areas occupied by the Hap soils. The soils, which are characterized by their fine gravel content and resulting gritty textures, are developing dominantly in old valley fill sediments of granitic origin.

Native vegetation includes sand dropseed, black grama, sideoats grama, bush muhly, fluffgrass, three-awns, mesquite, yucca, mormon tea, and various species of cacti. Under good management, fair yields of forage are obtained.

Soil Characteristics. Sonoita soils, the most extensive in the association, occur on gently sloping and undulating piedmont slopes. They normally have a thin surface layer of brown noncalcareous sandy loam or gravelly sandy loam. This is underlain by a brown or reddish-brown gravelly sandy clay loam subsoil. The substratum is a gravelly sandy loam, which usually becomes very gravelly below an average depth of about 40 inches.

Yturbide soils occupy gently sloping and undulating alluvial fan surfaces and aggraded stream channels. They have loamy sand surface layers and gravelly loamy sand subsoils. The substratum consists of stratified loamy sand, sand, and gravel with gravel content ranging from about 15 to 35 percent.

Hap soils occur dominantly on gently to strongly sloping and undulating alluvial fans at the base of mountain ranges. These soils, which are moderately deep, usually have a thin surface layer of brown gravelly loam. Their subsoil is a reddish-brown to red fine gravelly sandy clay loam. The subsoil, at a depth ranging from 20 to 50 inches, is underlain by a pinkish-white soft to weakly cemented gravelly caliche.

Also in this association are Mohave and Stellar soils, which are deep, and Forrest soils, which are moderately deep over gravelly caliche. Gravelly alluvial land and arroyo bottoms are minor inclusions which comprise approximately five percent of the association.

Irrigation Potential. Although these soils do have some limitations, their properties in general make them suitable for use as cropland under irrigation. Approximately 5 percent of the land in this

association is in irrigation land class 2; 90 percent in class 3; and the remaining 5 percent is non-irrigable, or in land class 6. The major soils of this unit (the Sonoita, Yturbide, and Hap series) are in irrigation land class 3. The coarse and gravelly textures, together with their limited water-holding capacity and slope, are the principal reasons for placing these soils in class 3. These lands will require a high level of management to obtain moderate to high yields of climatically adapted crops.

5. Nickel-Upton-Tres Hermanos association

The gently to strongly sloping and undulating piedmont slopes at the base of the desert mountains and hills are included in this association. It is common for this general soil area to completely surround the rough broken and rockland areas dominated by hills and low mountains. The soils, which are generally gravelly, are forming in coarse-textured alluvial fan sediments of mixed origin. This unit is dissected by numerous ephemeral streams and arroyos originating in the adjacent mountain areas. It includes an area of 78,435 acres, or three percent of the county.

This association, which supports a sparse to fair cover of vegetation, is used for grazing of livestock and wildlife. The more common grasses include fluffgrass, burrograss, black grama, sideoats grama, blue grama, bush muhly, tobosa, and three-awns. The association, however, generally appears to be dominated by shrubs, mainly creosotebush with lesser amounts of tarbush, broom snakeweed, yucca, and various species of cacti.

Soil Characteristics. Nickel soils occupy gently to strongly sloping and undulating landscapes at the base of desert mountains. They typically have a thin surface layer of pale brown or light brownish-gray weakly calcareous gravelly sandy loam. The subsoil is a light brown gravelly or very gravelly loam. This layer grades to white, very gravelly and weakly cemented caliche at depths of 15 to 25 inches. The lime content and cementation decrease with depth. This is in contrast to the coarse fragments which usually increase in size and amount with depth.

Upton soils, similar to those of the associated Nickel series, also occur on gently to strongly sloping and slightly undulating landscapes. They normally have a thin surface layer of light brownish-gray gravelly loam. This layer grades through a pale brown very limy gravelly loam to

strongly cemented or indurated caliche at depths of about 6 to 20 inches. The degree of cementation becomes less or weaker with depth.

Tres Hermanos soils, the least extensive of the major soils, usually occur on the more gently sloping landscapes in this association. They have a thin surface layer of light brown gravelly clay loam or gravelly loam. Their subsoil is reddish-brown gravelly clay loam that contains a moderate to high content of lime in the lower part. This is underlain by a pinkish-white limy very gravelly loam. It is typical for this soil to contain less lime and more gravel and sand below an average depth of 40 inches.

Also in this association are small areas of the moderately deep limy Turney soils, the deep Mohave, Mimbres, and Bluepoint soils, and the shallow Lehmanns soils. Rough broken land, arroyo bottoms, and other miscellaneous land types also comprise minor acreages in this association. Included minor soils and land types comprise about 25 percent of this association.

Irrigation Potential. The potential for development of irrigated land in this association is very limited due to moderately rough and broken topography, steep slopes, and shallow gravelly soils. Tres Hermanos, the only major soil in the association classified as suitable for irrigation, has moderate to severe limitations for such use. These soils were placed in class 3 because of the limited depth of effective soil material, gravel content, and low water-holding capacity. In addition to the major soils, small acreages of the less extensive soils including those of the Mimbres, Bluepoint, and Mohave series have been placed in an irrigable class. The location, shape, and small extent of these soils will tend to limit their use as irrigated cropland.

6. Eba association

This association, the smallest in the county, consists of one area comprising approximately 5,620 acres. It occurs in the east-central part of the county adjacent to the Grant-Luna county boundary where it joins an area of this association in Luna County. Although there are a few smooth strongly sloping land surfaces, this area in general is dissected by numerous ephemeral streams or arroyos originating in the adjacent mountains. The soils, which are usually gravelly and cobbly, are forming in alluvial fan sediments that are dominantly of acid igneous origin.

It is used for grazing of livestock and wildlife, and under good management fair yields of forage

are obtained. The more common native vegetation includes three-awns, tobosa, burgrass, black grama, sideoats grama, bush muhly, creosotebush, and lesser amounts of tarbush, broom snakeweed, yucca, and various species of cacti.

Soil Characteristics. Eba soils, the most extensive in the association, usually have a thin surface layer of brown to reddish-brown noncalcareous gravelly clay loam. The texture of the surface layer, however, may range from a very gravelly sandy loam to very gravelly clay loam. The subsoil, which is 24 to 30 inches thick, ranges from a very gravelly clay loam to a very gravelly clay. The substratum is a reddish-brown very gravelly and cobbly clay. It is commonly high in lime in the upper part and often weakly cemented.

Although of much lesser extent, soils of the Sonoita and Nickel series are of some importance in this association. The Sonoita soils occur on the gently sloping landscapes in this association. They usually have a thin surface layer of brown noncalcareous gravelly sandy loam. This is underlain by a brown to reddish-brown gravelly sandy clay loam subsoil. The substratum is a gravelly sandy loam which typically becomes very gravelly at depths of 30 to 40 inches. A zone of moderate lime accumulation occurs at a depth of 24 to 48 inches. The Nickel soils, which are shallow, are underlain by very gravelly and weakly cemented caliche at depths of 15 to 25 inches. They have a pale brown or light brownish-gray weakly calcareous gravelly sandy loam surface layer and a light brown gravelly loam subsoil.

Irrigation Potential. This association is dominated by class 6 land; so there is essentially no potential for development of irrigated land. Approximately 84 percent of this association has been placed in class 6; 15 percent in class 3; and 1 percent in class 2. The Sonoita soils account for most of the land in this unit classified as suitable for irrigation. The small size and common occurrence of the class 3 land, intermingled with class 6 land, will generally preclude its consideration for irrigation.

7. Rockland-Lehmans association

The mountain ranges, ridges, and hills, which are widely distributed throughout the southern part of the county, are included in this association. A characteristic feature of this unit, therefore, is the steep to extremely steep slopes and shallow and rocky soils with numerous exposures of bedrock.

Although the soils in this association are developing in materials from a wide variety of bedrock types, those forming in material of acid igneous origin are the most extensive. Basalt, limestone, and various other types of rocks have also contributed significantly to the materials in which these soils are forming. Approximately 175,205 acres, or seven percent of the county, are included in this association.

It is used principally for grazing of livestock and wildlife. The grazing by livestock in many parts of this unit is severely limited by steep slopes and the rocky or stony nature of the land surface.

Although the density of vegetation is somewhat restricted due to rock outcrops, thin soils, and steep slopes, this association does support a wide variety of grasses, shrubs, and a few scrub trees. This vegetative cover, together with associated land features, provides a good habitat for many species of wildlife. Black grama, blue grama, sideoats grama, bush muhly, Indian ricegrass, galleta, sand dropseed, and three-awns are the more common grasses. Shrubs and woody species include creosotebush, yucca, apache plume, wolfberry, live oak, pinyon, and juniper.

Soil Characteristics. Rockland, a miscellaneous land type, is a major component of this association. It is a complex of very shallow soils and exposures of bedrock. The bedrock commonly occurs as vertical or nearly vertical exposures and ledges. A thin mantle of cobbly or stony soil material commonly occurs between the outcrops of bedrock.

Lehmans soils occur on the moderately steep and rolling to hilly landscapes in this association. They usually have a thin surface layer of brown stony loam. The subsoil is a reddish-brown gravelly or stony clay. The stones and gravels may be lime-coated on the underside in the lower part of this horizon. These soils are typically underlain by acid igneous bedrock within 20 inches of the surface.

Also included in this association are shallow soils of the Nickel and Upton series, rough broken and stony land, gravelly alluvial land, and isolated pockets or extremely small acres of moderately deep and deep unclassified soils. These inclusions, none of which are extensive, comprise about 15 percent of the association.

Irrigation Potential. There is no potential for expansion of irrigated land in this association. The shallow soils, together with rock outcrops, steep slopes, and rough broken topography, preclude the use of the land in this association for irrigation.

8. Lonti-Poley-Pastura association

Included in this association are soils occurring on nearly level to gently sloping old alluvial terraces and piedmont slopes. In addition to this characteristic type of topography, small areas of moderately steep and dissected landscapes commonly occur adjacent to arroyos or drainageways. Although a number of units of this association occur on upland terraces adjacent to the Gila River and its tributaries in the northwestern part, it is mainly on piedmont slopes in the south-central part of the county. These soils, which are commonly gravelly, are forming in old alluvium dominated by materials of acid igneous origin. Variable amounts of gravel ranging from 10 to 25 percent by volume usually are present throughout the soil. The amount of cobble and gravel in the substrata often increases with depth.

The dominant use made of land in this association is grazing. Under good management, moderate yields of forage are obtained. Black grama, blue grama, sideoats grama, tobosa, sand drowsed and three-awns are the principal grasses. The more common shrubs include chamiza, snake weed, winterfat, and yucca.

This association includes about 172,625 acres, or seven percent of the county.

Soil Characteristics. Lonti soils, which are the most extensive, have a thin surface layer of brown noncalcareous gravelly loam or gravelly sandy clay loam. Their subsoil is a thick reddish-brown noncalcareous gravelly clay or gravelly heavy clay loam. This is underlain by a light reddish-brown weakly calcareous gravelly to a very gravelly sandy clay loam.

Poley soils, the other principal member of this association, differ from the Lonti soils in that they are moderately deep over a strong lime zone. They have a thin surface layer of reddish-brown noncalcareous gravelly loam over a reddish-brown gravelly clay or heavy gravelly clay loam subsoil that is free of lime in the upper part. This is underlain by weakly cemented gravelly and cobbly caliche at depths of 20 to 36 inches.

Pastura soils, the least extensive of major soils, occur on nearly level crests of upland plains and ridges. These soils have thin light brownish-gray calcareous gravelly loam surface layers and pale brown calcareous gravelly loam subsoils. They are underlain by indurated caliche at depths ranging from 6 to 20 inches. The degree of cementation in this caliche layer decreases with depth.

Also in this association are soils of Manzano and Hap series, a number of unclassified soils, and

miscellaneous land types including rough broken land and gravelly alluvial land. The Manzano soils, which are deep, dark colored, and moderately fine-textured, occupy nearly level to gently sloping valley bottoms. The Hap soils, which occur dominantly on gently to strongly sloping piedmont slopes at the base of mountain ranges, are underlain at depths of 20 to 50 inches by a pinkish-white soft to weakly cemented caliche. The unclassified soils include a soil that has surface layer and subsoil similar to those of the Lonti, but differs in that it is underlain by gravel and cobble or very gravelly sandy loam or sand at depths of 20 to 36 inches. Other inclusions are gravelly loam soils on long narrow ridges, breaks and side slopes of small arroyos. These gravelly soils are calcareous and weakly developed. The rough broken land includes the moderately steep and dissected areas adjacent to the drainageways. It consists of a complex of shallow soils and exposures of unconsolidated sedimentary deposits. These included soils and miscellaneous land types comprise approximately 30 percent of this association.

This association in the southern part of the county joins the Mohave-Stellar association of Luna County. The boundary between these two associations occurs near the Grant and Luna county boundary and consequently, for convenience, the separation was made at the county boundary.

Irrigation Potential. This association, which is dominated by land in classes 3 and 2, offers considerable potential for expansion of irrigation, particularly in the large and extensive area in the southern part of the county. Approximately 45 percent of the land in this association is in class 3; 30 percent is in class 2; 5 percent is in class 4; 2 percent is in class 1; and the remaining 18 percent is non-irrigable, or in class 6. The nearly level to gently sloping Lonti soils were placed in irrigation land class 2 and the strongly sloping phases in class 3. Soils of the Poley and Hap series, however, account for most of the land in class 3. The coarse and gravelly-textures, together with their limited water-holding capacity, are the principal factors or reasons for placing them in class 3.

9. Rough Broken Land-Lonti association

This association which is widely distributed through the central and west parts of the county consists of an area of about 203,025 acres, or eight percent of the county. A characteristic feature is the rough and broken nature of the land surface that is steep to very steep and dissected by



Fig. 4. Typical landscapes in the Rough Broken Land-Lonti association. Lonti soils occur on the gently to strongly sloping ridge crests and old terrace tops. The steep to very steep side slopes are included in rough broken land.

numerous intermittent drainages and arroyos. In addition to this prevailing type of topography, small areas on ridge crests or on the old terrace tops are gently to strongly sloping and rolling. A few narrow valley bottoms and flood plains on nearly level to gently sloping landscapes are also included.

The soils in this association are forming generally in material of alluvial origin. The stratified old alluvial sediments that underlie the soils of this unit at variable depths are dominantly coarse to medium-textured, gravelly, and cobbly. In general, the soils of this association have noncalcareous to weakly calcareous gravelly sandy loam or gravelly loam surface layers. Gravel and cobble are common over much of the surface, and in many places this mantle of coarse fragments has tended to reduce soil erosion.

Vegetation on this association ranges from a sparse cover on some of the very steep slopes and breaks to moderate stands on the less sloping and more stable landscapes. It supports, however, a wide variety of grasses including black grama, sideoats grama, blue grama, bush muhly, little bluestem, Arizona cottontop, fluffgrass and three-awns. The more common shrubs and woody species are shrub juniper, oakbrush, catclaw, cliff rose, Apache plume, and broom snakeweed.

Soil Characteristics. Rough broken land, the most extensive, includes the steep to very steep

and severely dissected lands in this association. It consists of a complex of shallow gravelly soils and exposures of unconsolidated to weakly consolidated sedimentary deposits dominated by gravelly and loamy or sandy sediments. Barren to nearly barren erosional remnants capped by moderately erosion-resistant conglomerates occur frequently through this unit. Erosion in general is active, and as a result the rough broken land component of this association contributes considerable sediments to the drainage system.

Lonti soils, which occupy the more stable landscapes in this association, occur on the gently to strongly sloping and rolling ridge crests. They have a thin surface layer of brown noncalcareous gravelly loam or gravelly sandy loam over a thick reddish-brown gravelly clay loam or gravelly clay subsoil. This is underlain by a light reddish-brown slightly calcareous gravelly or very gravelly loam and sandy loam.

Also in this association are small acreages of a number of other miscellaneous land types such as rockland, alluvial land, gullied land and riverwash. Rockland, which consists of a complex of shallow soils and rock outcrops, including igneous dikes and sills, commonly occurs in the upper part of this unit where it joins the mountainous areas. Gullied land, alluvial land, and riverwash commonly occur in the narrow valley bottoms. In addition to the miscellaneous land types, unclassified soils also comprise minor acreages in this association. They have characteristics similar to the Lonti soils and, in this report, are grouped with the soils of that series.

Irrigation Potential. This association, which is dominated by class 6 land, offers little or no potential for expansion of irrigation. Approximately 80 percent of the land comprising this unit is in class 6; 10 percent is in class 4; and 10 percent is in class 3. The Lonti soils account for most of the land classified as suitable for irrigation. The gravel and cobble content, unevenness of the land surface, slope, and erosion hazard, together with a moderate water-holding capacity, were the principal reasons for placing these soils in land classes 3 and 4. Furthermore, the irrigable lands are widely distributed and usually occur in small and irregularly shaped tracts. This will undoubtedly tend to further restrict their use for irrigation.

10. Lonti-Rough Broken Land association

This association, which includes an area of about 135,700 acres, occurs on rolling to hilly uplands

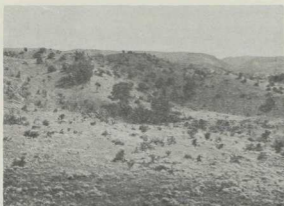


Fig. 5. A general view of rolling landscapes occupied by the Lonti soils in association 10. A small area of the San Mateo-Shanta association shown in the right foreground.

with slope gradients that are dominantly between 10 and 35 percent. It occurs in close association with soil association No. 9, but differs in that it is not as steep or as severely dissected.

The major and more extensive soils in this association are forming in stratified old alluvial sediments that are dominantly gravelly, cobbly, and coarse to medium-textured. In general, these soils have noncalcareous to mildly alkaline surface layers. Gravel and cobble, which are common over much of the surface, have tended to stabilize the land surface and reduce soil erosion.

It supports a fair to good stand of native vegetation, including a thin and scattered overstory of pinyon and juniper trees. Other woody species and shrubs include Apache plume, oakbrush, cat-claw, cliff rose, and broom snakeweed. The more common grasses are black grama, blue grama, sideoats grama, little bluestem, bush muhly, Arizona cottontop, fluffgrass and three-awns.

Soil Characteristics. The Lonti soils, which are the most extensive, occur on moderately steep and rolling landscapes in this association. Slope gradients average about 15 percent, but may range from about 10 to 30 percent. These soils have a thin surface layer of brown noncalcareous gravelly loam or gravelly sandy clay loam. Their subsoil is a thick reddish-brown noncalcareous gravelly clay or heavy gravelly clay loam. This is underlain by a light reddish-brown weakly calcareous gravelly to a very gravelly sandy clay loam.

Rough broken land, the other major component of this association, occurs on the rough, broken, and steep landscapes. It consists of a complex of shallow gravelly soils and exposures of unconsolidated to weakly consolidated sedimentary deposits. These exposed sedimentary materials are gravelly and cobbly and dominantly moderately coarse to medium-textured.

Other soils of importance in this association include those of the Poley and Pastura series. The Poley soils, which have gravelly loam surface layers and gravelly clay loam or gravelly clay subsoils, are underlain by a weakly cemented gravelly and cobbly caliche at depths of 20 to 40 inches. The Pastura soils differ from the Poley soils in that they have a coarser-textured subsoil and are underlain by indurated caliche at a shallow depth. Also in this association are a number of unclassified soils. Some of these have characteristics similar to the Lonti soils and, in this report, are grouped with soils of this series. One of the more extensive of the unclassified soils has a gravelly loam surface layer and a gravelly clay loam subsoil. It is underlain by stratified very gravelly loams, very gravelly sandy loams, and gravel and sand at depths of 20 to 40 inches. Miscellaneous land types, including gravelly alluvial land, riverwash, and arroyo bottoms comprise the remaining parts of this association.

Irrigation Potential. Approximately three-fourths of the land in this association has been classified as non-irrigable because of unfavorable soil properties and the rough broken, steep, and dissected landscapes. The remaining land is dominantly in class 4, and a small acreage is in class 3. The strongly sloping and rolling topography, gravel and cobble content, and limited water-holding capacity were the principal factors contributing to the classification of these lands. In addition to their relatively low capability for irrigation, they commonly occur as small and widely distributed tracts intermingled with extensive areas of non-irrigable land. The potential for expansion of irrigation on the lands comprising this unit is, therefore, extremely limited.

11. Luzena-Arp association

Included in this association are a number of widely separated areas in the south-central and northwestern parts of the county. It is a relatively extensive association, comprising an area of approximately 198,190 acres. It is characterized by rolling to hilly landscapes interspersed with nearly

level to gently sloping narrow valley bottoms and terraces. A few steep to very steep canyon walls and breaks are also included. In the areas dominated by rolling to hilly landscapes, the soils range from shallow to moderately deep. Deep soils are common in the nearly level to gently sloping valley bottoms between the hills.

The soils are developing dominantly in materials of acid igneous origin including conglomerates of the Gila and Datil formations. Sedimentary materials, particularly limestone and shale, are contributing minor amounts to the parent materials in the extreme eastern parts of this association. Gravel and a few cobbles and stones are common over much of the land surface.

This association supports a good cover of vegetation which is dominated by short and mid grasses with a scattered canopy of shrubs and pinyon, juniper, and oak trees. Cottonwood, desert willow, and walnut trees occur in the valley bottoms contiguous to the drainages. The more common grasses and shrubs are blue grama, black grama, hairy grama, sideoats grama, bluestem, mountain muhly, Medcalf muhly, mountain brome grass, junegrass, pine dropseed, little bluestem, sacahuista, and snakeweed.

Soil Characteristics. Luzena soils, one of the more extensive soils in this association, occur on moderately steep and hilly landscapes. They are moderately dark colored, noncalcareous or neutral in reaction, and shallow. The surface layer is usually a thin brown gravelly or cobbly loam. This is underlain by a brown to dark reddish-brown noncalcareous gravelly clay or gravelly clay loam. Igneous bedrock or conglomerate commonly occurs within 20 inches of the surface. The underlying bedrock is generally fractured and weathered in the upper part.

Arp soils also occupy rolling and hilly landscapes with slopes ranging between 10 and 30 percent. These soils have a thin surface layer of brown noncalcareous gravelly loam over a reddish-brown, noncalcareous gravelly clay or clay subsoil. This is underlain at a depth ranging from 20 to 40 inches by acid igneous bedrock or conglomerate commonly fractured and weathered in the upper part.

Soils of the Balon series also comprise a relatively large acreage in this association. These soils occupy gently sloping to moderately steep alluvial slopes and fans on the lower parts of hills and ridges. They consist of deep soils with thin dark colored gravelly sandy clay loam surface layers, heavy clay loam and gravelly clay loam subsoils, and gravelly sandy clay loam or gravelly sandy loam substrata.

The remaining parts of this association consist of miscellaneous land types including rockland, rough broken land, and arroyo bottoms, and soils of the Oro Grande and Manzano series, as well as small acreages of deep unclassified soils. The Oro Grande soils, which are underlain by igneous bedrock within a depth of 20 inches, consist of steep calcareous stony loams or stony light clay loams. The Manzano soils are deep and have a moderately thick surface layer of grayish-brown loam over a thick subsoil of dark grayish-brown clay loam. These soils usually occur in swales and narrow valley bottoms. The majority of the unclassified soils are similar to those of the Manzano series, but differ in that the subsurface layers consist dominantly of sandy loams or light loams. They occur as a complex in the form of small areas or pockets with extensive areas of shallow soils.

Irrigation Potential. There is essentially no potential for development of irrigated land in this association. The only soils with properties suitable for irrigation are the small areas of deep alluvial soils and those of the Manzano series. The small size, location, and isolated nature of these irrigable lands will generally preclude their use for this purpose.

12. Cabezon-Thunderbird association

This association, consisting of approximately 17,245 acres, includes five widely separated areas in the northwestern part of the county. Included are areas with soils forming in materials of volcanic and basic igneous origin on old lava flows and basalt capped mesas. A characteristic feature of this unit is the stony and rocky nature of many of the included soils. Small ridges are common where bedrock outcrops or the shallow^o soils are extremely stony. Although the depth or thickness of the soils is quite variable, they are dominantly shallow to moderately deep. The land surface on the mesa tops and lava flows is dominantly gently to strongly sloping and undulating, but may range from nearly level to moderately steep. The sides of the basalt capped mesas and the fronts of lava flows are generally steep or very steep.

It is dominated by grass vegetation, including sideoats grama, blue grama, hairy grama, vine mesquite, plains lovegrass, Arizona cottontop, tobosa, creeping muhly, fluffgrass, and three-awns. In addition to the grass vegetation, it also supports some shrubs and woody species such as chamiza, yucca, oakbrush, catclaw, broom snakeweed, a few junipers, and various species of cacti.

Soil Characteristics. Cabezon soils consist of shallow dark colored soils on gently to strongly sloping and undulating mesa tops and fronts of lava flows. Surface stones and a few outcrops of basalt are common. These soils have a surface layer of dark grayish-brown, noncalcareous stony loam or stony clay loam. Their subsoil is a brown cobbly or stony clay. This is underlain by basalt bedrock at depths ranging from 10 to 24 inches. The underlying basalt bedrock, which is commonly fractured, is typically lime-coated in the upper part.

Thunderbird soils commonly occupy the nearly level to gently sloping grassland areas on basalt capped mesas. They have a thin surface layer of grayish-brown noncalcareous stony clay loam. Their subsoil is a grayish-brown noncalcareous cobbly clay. This grades through to a strongly calcareous gravelly or cobbly clay loam to the underlying bedrock at depths ranging between 20 and 40 inches.

Basalt rockland, a miscellaneous land type, is also an important component of this association. It occurs on the steep to very steep mesa breaks, fronts of lava flows, and isolated ridges dominated by outcrops of basalt and extremely stony soils. It consists of a complex of shallow stony soils and exposures or outcrops of basalt bedrock. Much of the surface between the outcrops of basalt is covered with stones and boulders.

The remaining parts of this association include soils of the Torreon series, deep clayey soils, and other miscellaneous land types. The Torreon soils are deep and have brown noncalcareous moderately thick loam or light clay loam surface layers over thick blocky clay subsoils. This is underlain at a depth of 36 to 50 inches by a brown calcareous clay loam with many medium to large soft masses and streaks of lime. The deep clayey soils, which are also forming in material weathered from basalt, occur in nearly level to very gently sloping slight depressional areas. The surface layers and subsurface layers are clay or silty clay and crack widely and deeply upon drying.

Irrigation Potential. The potential for development of irrigated land in this association is extremely limited. The Cabezon soils, the most extensive in the association, are not suitable for use as cropland under irrigation. The only soils in this unit suitable for irrigation are those of the Torreon series, the deep clayey soils and a small acreage of the Thunderbird soils that are non-stony. Approximately 11 percent of the land in this association is in class 4; 10 percent is in class 2; 2 percent is in class 3; and the remaining 77 percent is non-irrigable or in class 6. The small acreage of irrigable

land in this unit is widely distributed and intermingled with extensive areas of class 6 land.

13. San Mateo-Shanta association

Included in this association are the nearly level to gently sloping flood plains and valley bottoms adjacent to the Gila and Mimbres rivers, as well as some of the larger tributaries. The soils are quite variable and, as a result, the texture of the surface layers may range from sand to clay; however, sandy loam, loam, and clay loam are the more common textures.

The major part of the 9,130 acres of irrigated land in Grant County is in this association. Although a wide variety of crops is grown, alfalfa, orchards, and irrigated pastures are the most extensive. Other crops of importance include vegetables, small grains, and sorghum. In addition to the irrigated land, a considerable acreage of land in this unit is occupied by roads, highways, buildings, and other built-up areas. Although there are many soils in this unit with properties suitable for engineering installations, the association includes small areas of wet soils as well as soils with moderate to high shrink-swell potential and low bearing capacities that will need special consideration if used for installation of structures. Localized areas of these soils also need protection from flooding by runoff from adjacent higher lying lands. Those not under irrigation provide grazing for livestock and wildlife. Production of forage varies considerably, depending on the amount of additional moisture received by runoff from adjacent areas. Vegetation on these non-irrigated areas is dominated by mid and short grasses, shrubs, and scattered pinyon, juniper, and oak trees. Cottonwood trees are common on the flood plain contiguous to the Gila River. Approximately 35,960 acres, or slightly more than one percent of the county, is included in this association.

Soil Characteristics. San Mateo loam, the most extensive in this association, usually has a surface layer of calcareous grayish-brown loam. This is underlain to a depth of five feet or more by stratified soil material consisting dominantly of loam, sandy clay loam, light clay loam, and sandy loam.

Shanta soils, which occur on terminal points of alluvial fans, valley bottoms, and depressional areas, are also important in this association. These soils have a thick surface layer of brown or grayish-brown calcareous loam. This is underlain to depths of five feet or more by loam or light clay

loam. A few pebbles and cobbles commonly occur in the subsurface layers.

Glenberg-like soils differ from San Mateo soils in that they are coarser-textured and contain more strata of sandy loam, loamy sand, and light loams. These soils have a surface layer of brown to grayish-brown calcareous fine sandy loam or loam. This is underlain to depths of five feet or more by stratified soil material consisting dominantly of sandy loam and loam with some thin strata of loamy sand. Also included with the Glenberg-like soils is a medium and moderately coarse-textured soil underlain by sand at moderate depths. These soils have a surface layer of grayish-brown calcareous loam or fine sandy loam. The subsurface layers above the sand, which occurs at depths ranging from 20 to 40 inches, consist dominantly of stratified sandy loams and light loams.

The remaining parts of this association consist of a number of other unnamed soils and miscellaneous land types. These inclusions, none of which are extensive, comprise about 20 percent of the association. The included soils are dominated by shallow and moderately deep soils over sand and gravel, deep sandy soils, and deep clayey soils. A small acreage of wet and saline soils, which are usually adjacent to the streams, is also included. The miscellaneous land types include riverwash, arroyo bottoms, river bottoms, and gullied land.

Irrigation Potential. Approximately 92 percent of the land in this association has been classified as irrigable. In general, the only lands not irrigable include the immediate flood plain of the larger streams and the river and arroyo bottoms. The soils are well suited for use as cropland under irrigation, and, as a result, about 80 percent of the land in this unit has been placed in irrigation land classes 1 and 2. Besides good farming practices, these lands often need protection from overflow or runoff from higher lying lands. This is a small association, so the amount of land available for expansion of irrigation is limited. In addition, the almost 5,000 acres that are already irrigated, along with roads and a few built-up areas, further restrict the acreage of land available for future development of irrigation.

14. Rockland-Luzena-Santana association

This association, the largest in the county, includes an area of about 839,870 acres, or approximately 33 percent of the county. It includes the hilly to very steep mountain foothill and intermediate mountain areas. The relatively narrow

valley floors and upland summits are commonly separated by steep canyon walls, escarpments, and steep side slopes. The ridge tops, which are narrow and comparatively small, are gently to strongly sloping and rolling. The narrow valley floors below the steep canyon walls and steep side slopes are gently to strongly sloping. Although there is a relatively wide range in altitude, most of this area ranges between 5,000 and 8,000 feet in elevation.

The soils, which are forming in materials from a wide variety of rocks including conglomerates and mixed igneous rocks, are generally shallow to moderately deep. Rock outcrops are common along canyon walls and on the steep side slopes below the upland ridges. Although the content of gravel and stones is highly variable, most soils in this association have stony or gravelly surface layers.

These steep and rough broken lands support a wide variety of grasses, shrubs, and some trees. Vegetation on much of this area, however, is dominated by mid and short grasses with a scattered canopy of pinyon and juniper trees, oakbrush, and various other shrubs. Some of the more common grasses are blue grama, sideoats grama, black grama, little bluestem, needle and thread, New Mexico feathergrass, bush muhly, mesa dropseed, Arizona cottontop, hairy grama, and threeawns. Shrubs, in addition to oakbrush, include sacahuista, buck brush, mountain mahogany, Apache plume, rabbitbrush, chamiza, and winterfat. There are a few ponderosa pine, particularly in

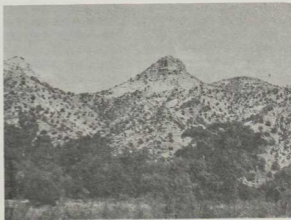


Fig. 6. Rockland-Luzena-Santana association. Luzena and Santana soils are located on the saddles and crests of rolling hills.

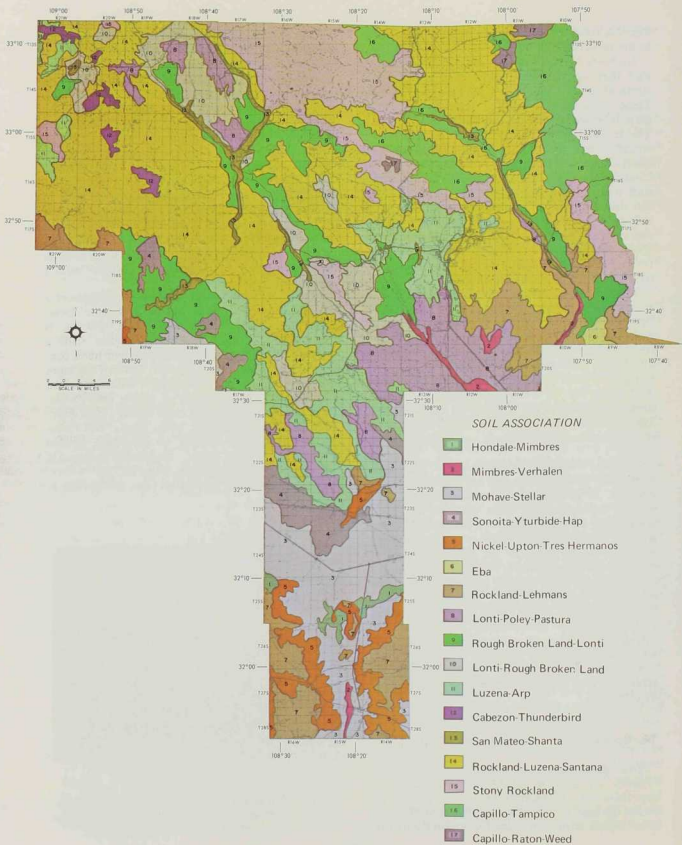


Figure 1. General Soil Map of Grant County, New Mexico

Table 4. Soil characteristics and qualities of major soils in each soil association, Grant County, New Mexico

Soil Map Symbol and Soil Association	Dominant Slope Range (percent)	Approximate Percent of Association	Pedologic Classification		Texture ¹
			Subgroup	Family	
1 Hondale-Mimbres					
Hondale silt loam	0 to 1	50	Typic Natragrid	Fine, mixed, thermic	sil:slcl
Mimbres silty clay loam	0 to 1	30	Typic Camborthid	Fine-silty, mixed, thermic	slcl:loam
Other soils		20			
2 Mimbres-Verhalen					
Mimbres silty clay loam	0 to 1	45	(See association 1)		
Verhalen silty clay loam	0 to 1	40	Mollic Torrert	Fine, montmorillonitic, thermic	slcl:slc
Other soils and land types		15			
3 Mohave-Stellar					
Mohave sandy clay loam	0 to 3	30	Typic Haplargid	Fine-loamy, mixed, thermic	sl:sl:loam
Stellar silty clay loam	0 to 3	25	Typic Haplargid	Fine-mixed thermic	slcl:slcl
Other soils and land types					
Berino sandy loam	0 to 3	5	Typic Haplargid	Fine-loamy, mixed, thermic	sl:ls
Forrest gravelly loam	0 to 5	5	Typic Haplargid	Fine, mixed, thermic	gl:loam
Other soils and land types		35			
4 Sonoita-Yturbi-de-Hap					
Sonoita gravelly sandy loam	0 to 5	40	Typic Haplargid	Fine-loamy, mixed, thermic	gs:sl
Yturbi-de loamy sand	0 to 3	25	Typic Torripsamment	Mixed, thermic	ls:gl:sl
Hap gravelly loam	1 to 9	25	Typic Haplargid	Fine-loamy, mixed, thermic	gl:sl
Other soils and land types		10			
5 Nickel-Upton-Tres Hermanos					
Nickel gravelly sandy loam	1 to 9	30	Typic Calcorthid	Loamy-skeletal, mixed, thermic	gs:gl
Other soils and land types					
Upton gravelly loam	1 to 9	25	Typic Paleorthid		gl
Tres Hermanos gravelly clay loam	0 to 5	20	Typic Haplargid	Fine-loamy, mixed, thermic	gl:glcl
Other soils and land types		25			
6 Eba					
Eba very gravelly loam	1 to 15	75	Typic Haplargid	Clayey-skeletal, montmorillonitic, thermic	vg:vgcl
Sonoita gravelly sandy loam	1 to 3	15	Typic Haplargid	Fine-loamy, mixed, thermic	gs:sl
Other soils and land types		10			
7 Rockland-Lehmans					
Rockland	15 to 75	50	(A miscellaneous land type)		
Lehmans rocky loam	5 to 25	35	Lithic Haplargid	Clayey, montmorillonitic, thermic	rl
Other soils and land types		15			
8 Lonti-Poley-Pastura					
Lonti gravelly loam	0 to 5	35	Ustollic Haplargid	Fine, mixed, mesic	gl:gscl:sl
Poley gravelly loam	0 to 3	25	Ustollic Haplargid	Fine, mixed, mesic	gl:gscl:sl
Pastura gravelly loam	0 to 3	10	Ustollic Paleorthid	Loamy, mixed, mesic, shallow	gl:loam
Other soils and land types		30			
9 Rough Broken Land-Lonti					
Rough broken land	30 to 75	75	(A miscellaneous land type)		
Lonti gravelly loam	3 to 15	20	Ustollic Haplargid	Fine, mixed, mesic	gl:gscl:sl
Other soils and land types		5			
10 Lonti-Rough Broken Land					
Lonti gravelly loam	10 to 30	60	(See association 9)		
Rough broken land	15 to 65	25	(A miscellaneous land type)		
Other soils and land types		15			
11 Luzena-Arp					
Luzena cobbly loam	10 to 30	30	Aridic Lithic Argustoll	Clayey, montmorillonitic, mesic	col:gl
Arp gravelly loam	10 to 30	30	Ustollic Haplargid	Fine, montmorillonitic, mesic	gl:glcl
Balon gravelly loam	5 to 25	15	Ustollic Haplargid	Fine-loamy mixed, mesic	gscl:sl
Other soils and land types		25			
12 Cabezon-Thunderbird					
Cabezon stony clay loam	0 to 9	40	Aridic Lithic Argustoll	Clayey, montmorillonitic, mesic	stcl:stl
Thunderbird stony clay loam	0 to 9	30	Aridic Argustoll	Fine, montmorillonitic, mesic	stcl:stl
Basalt rockland	15 to 50	15	(A miscellaneous land type)		
Other soils and land types		15			
13 San Mateo-Shanta					
San Mateo loam	0 to 2	30	Ustic Torrifluent	Fine-loamy, mixed, mesic	Loam:cl
Shanta loam	2 to 5	25	Cumulic Hapustoll	Fine-loamy, mixed, mesic	Loam:sl:cl
Glenberg-like fine sandy loam	0 to 2	25	Ustic Torrifluent	Coarse-loamy, mixed, mesic	Loam:sl
Other soils and land types		20			

Surface Soil Features		Subsoil Features			Substratum	Soil Depth ⁴ (inches)	AWHC ⁵ (inches)
Color ²	Reaction	Texture ¹	Color ²	Permeability ³			
Light brownish-gray	Calcareous	Clay;cl	Light brown to reddish-brown	Very slow	Loamy alluvium	60 or more	7
Light brownish-gray	Non-calc.	sic;cl	Light brown	Slow	Loamy alluvium	60 or more	8
Brown	Calcareous	Clay;stc	Brown	Very slow	Clayey alluvium	60 or more	8
Brown to reddish-brown	Non-calc.	cl	Reddish-brown	Slow	Calcareous alluvium	60 or more	6 to 7
Pale brown to pinkish-gray	Non-calc.	Clay;cl	Reddish-brown	Slow	Calcareous alluvium	60 or more	6 to 7
Brown to reddish-brown	Non-calc.	sel	Reddish-brown	Moderate	Calcareous alluvium and soft caliche	36 to 50	5 to 6
Reddish-brown	Non-calc.	gc	Reddish-brown to red	Slow	Gravelly caliche	24 to 36	4
Brown	Non-calc.	gscl	Brown to reddish-brown	Moderate	Gravelly sandy loam	60 or more	4 to 5
Brown	Non-calc.	gls	Brown	Very rapid	Gravelly sand	60 or more	3 to 4
Brown	Non-calc.	gscl	Reddish-brown to red	Moderate	Weakly cemented caliche	20 to 50	3 to 4
Light brownish-gray	Calcareous	gl;vgl	Light brown	Rapid	Caliche; upper part weakly cemented	15 to 25	2
Light brownish-gray	Calcareous	gl	Pale brown or light brownish-gray	Moderate	Caliche; upper part strongly cemented	6 to 20	1 to 2
Light brown	Calcareous	gcl	Reddish-brown	Slow	Gravelly caliche and gravel	24 to 36	4
Reddish-brown	Non-calc.	vge	Red or reddish-brown	Slow	Weakly cemented caliche	20 to 36	2 to 3
Brown	Non-calc.	gscl	Brown to reddish-brown	Moderate	Gravelly sandy loam	60 or more	4 to 5
Brown	Non-calc.	stc;stcgc	Reddish-brown	Very slow	Acid igneous bedrock	10 to 20	2 to 3
Brown	Non-calc.	gc;gcl	Reddish-brown	Slow	Calcareous gravelly alluvium	60 or more	5 to 6
Reddish-brown	Non-calc.	gc;gcl	Reddish-brown	Slow	Weakly cemented gravelly caliche	20 to 36	4 to 4.5
Light brownish-gray	Calcareous	gl	Pale brown	Moderate	Indurated caliche	6 to 20	1 to 3
Brown	Non-calc.	gc;gcl	Reddish-brown	Slow	Calcareous gravelly alluvium	60 or more	5 to 6
Brown	Neutral	gc;gcl	Dark reddish-brown	Slow	Acid igneous bedrock	7 to 20	1 to 3
Brown	Neutral	gc;clay	Reddish-brown	Slow	Acid igneous bedrock	20 to 40	4 to 6
Grayish-brown	Neutral	cl;gcl	Brown	Moderate	Gravelly alluvium	60 or more	5 to 6
Dark grayish-brown	Non-calc.	oc;stc	Brown	Slow	Basalt bedrock	10 to 24	2 to 3
Grayish-brown	Non-calc.	oc;stc;clay	Grayish-brown	Slow to very slow	Basalt bedrock	20 to 40	
Grayish-brown	Calcareous	Loam;sel;cl	Grayish-brown and brown	Moderate	Loamy alluvium	48 to 60 or more	7 to 8
Brown or grayish-brown	Calcareous	Loam;cl	Brown	Moderate	Loamy alluvium	60 or more	7 to 8
Brown to grayish-brown	Calcareous	sl;loam;ls	Light brownish-gray	Moderate	Loamy alluvium	48 to 60 or more	4 to 7

Table 4. Continued

Soil Map Symbol and Soil Association	Dominant Slope Range (percent)	Approximate Percent of Association	Pedologic Classification		Texture ¹
			Subgroup	Family	
14 Rockland-Luzena-Santana					
Rockland	20 to 75+	35	(A miscellaneous land type)		
Luzena cobbly loam	20 to 50	15	Aridic Lithic Argiustoll	Clayey, montmorillonitic, mesic	col:gl
Santana stony loam	30 to 60	15	Aridic Lithic Haplustoll	Loamy, mixed, mesic	st:col
Other soils and land types		35			
15 Stony Rockland					
Rockland	20 to 75-	55	(A miscellaneous land type)		
Rough broken land	20 to 75-	15	(A miscellaneous land type)		
Luzena cobbly loam	20 to 50	10	Aridic Lithic Argiustoll	Clayey, montmorillonitic, mesic	col:gl
Cabezon stony loam	15 to 35	5	Aridic Lithic Argiustoll	Clayey, montmorillonitic, mesic	st:col;stl
Other soils and land types		15			
16 Capillo-Tampico					
Capillo gravelly loam	0 to 30	20	Typic Argiboroll	Fine, mixed	gl:stl
Tampico gravelly loam	30 to 60	20	Typic Cryoboroll	Fine-loamy, mixed	gl
Raton-like gravelly clay loam	30 to 65	18	Lithic Haploboroll	Loamy, mixed	gl:ycl
Rockland	30 to 75+	20	(A miscellaneous land type)		
Other soils and land types		22			
17 Capillo-Raton-Weed					
Capillo gravelly loam	0 to 30	30	Typic Argiboroll	Fine, mixed	gl:stl
Raton-like gravelly clay loam	10 to 35	20	Lithic Haploboroll	Loamy, mixed	gl:ycl
Weed gravelly loam	0 to 30	20	Pachic Argiboroll	Fine-loamy, mixed	gl:stl
Rockland	10 to 75+	10	(A miscellaneous land type)		
Other soils and land types		20			

¹Abbreviations used for textural classes:

la - loamy sand	gac - gravelly sandy clay	cl - clay loam	stc - silty clay
sl - sandy loam	gl - gravelly loam	siel - silty clay loam	gc - gravelly clay
fsl - fine sandy loam	vgl - very gravelly loam	gcl - gravelly clay loam	vgc - very gravelly clay
gls - gravelly loamy sand	col - cobbly loam	vycl - very gravelly clay loam	coc - cobbly clay
gal - gravelly sandy loam	stl - stony loam	coel - cobbly clay loam	stc - stony clay
scl - sandy clay loam	stll - silty loam	stcl - stony clay loam	

²Colors are for dry soil.

the northeastern part of this association, on north slopes and at the higher elevations. The steep slopes, rock ledges, and escarpments tend to restrict grazing by livestock in parts of this association. The areas with these characteristics, however, provide a good habitat for many species of wildlife.

Soil Characteristics. Approximately 35 percent of this association has been included in a land type identified as rockland. It is characterized by numerous outcrops of bedrock that usually occur on steep to very steep slopes. It consists of a complex of rock outcrops and shallow soils with variable characteristics. The shallow soils that are intermingled with rock outcrops, however, are generally gravelly or stony and moderately coarse to medium-textured. Stones and boulders occur on much of the soil surface. Although the soils are usually shallow, small areas of moderately deep soils do occur interspersed with the shallow soils, rock outcrops, and rock ledges.

Luzena soils are shallow, moderately dark colored, and are forming dominantly on acid igneous bedrock or conglomerate. They have a thin brown noncalcareous cobbly loam surface layer over a brown to dark reddish-brown clay or gravelly clay subsoil. Igneous bedrock or conglomerate typically occurs within 20 inches of the surface.

Soils of the Santana series are also relatively extensive in this association. They differ principally from the Luzena soils in that they lack the clayey or fine-textured subsoil. Typically the Santana soils have a grayish-brown to brown, neutral to slightly acid, stony loam surface layer. This grades through a brown cobbly or stony loam of similar reaction to the underlying igneous bedrock which is usually encountered within a depth of 20 inches.

Also in this association are soils of the Oro Grande, Cabezon, Chimayo, and Santa Fe series. The Oro Grande soils, which are underlain by

Surface Soil Features		Subsoil Features				Soil Depth ⁴ (inches)	AWHC ⁵ (inches)
Color ²	Reaction	Texture ¹	Color ²	Permeability ³	Substratum		
Brown	Neutral	gc;clay	Dark reddish-brown	Slow	Acid igneous bedrock	7 to 20	1 to 3
Grayish-brown	Neutral to slightly acid	col;stl	Brown	Moderate	Acid igneous bedrock	10 to 20	1 to 3
Brown	Neutral	gc;clay	Dark reddish-brown	Slow	Acid igneous bedrock	7 to 20	1 to 3
Dark grayish-brown	Non-calc.	co;cstc	Brown	Slow	Basalt bedrock	10 to 24	2 to 3
Dark brown	Neutral to slightly acid	gc;gcl	Brown	Slow	Mixed igneous rocks and conglomerate	20 to 40	4 to 6
Dark brown	Neutral to slightly acid	gcl;coel	Dark brown and brown	Moderate	Mixed igneous rocks and conglomerate	48 to 60	5 to 7
Dark brown	Neutral to slightly acid	gcl;gl	Brown	Moderate	Conglomerate and igneous bedrock	10 to 20	1 to 3
Dark brown	Neutral to slightly acid	gc;gcl	Brown	Slow	Mixed igneous rocks and conglomerate	20 to 40	4 to 6
Dark brown	Neutral to slightly acid	gcl;coel	Brown	Moderate	Conglomerate and igneous bedrock	10 to 20	1 to 3
Dark grayish-brown	Neutral to slightly acid	gel	Grayish-brown	Moderate	Conglomerate	20 to 40	4 to 6

³ Permeability classes and approximate rates per hour:

Very slow - less than 0.20 inches Rapid - 2.50 to 6.30 inches
 Slow - 0.20 to 0.63 inches Very rapid - more than 6.30 inches

Moderate - 0.63 to 2.50 inches

⁴ Depth in inches from surface of effective soil

⁵AWHC - Available water-holding capacity (estimated to a depth of 4 feet or for effective soil material if less than 4 feet)

igneous bedrock within 20 inches of the surface, have grayish-brown slightly calcareous stony surface layers and calcareous very cobbly light clay loam subsurface layers. the Cabezon soils have a surface layer of dark grayish-brown noncalcareous stony loam over a cobbly clay subsoil. This is underlain by basalt bedrock at depths ranging from 10 to 20 inches. Chimayo soils typically have grayish-brown, neutral stony surface layers, light brownish-gray noncalcareous very cobbly loam subsurface layers with igneous bedrock occurring at 20 inches or less. The Santa Fe soils, which are also shallow, have dark brown calcareous gravelly loam or clay loam surface layers and dark reddish-brown very gravelly clay loam subsoils.

Other soils and miscellaneous land types included in this association are deep alluvial soils, moderately deep and deep stony soils, rough broken land, alluvial land, arroyo bottoms, and drainageways. These inclusions, none of which are extensive, comprise about 10 percent or less of the association.

Irrigation Potential. Although this is a large association, there is very little or no potential for development of irrigated land. Less than one percent of the land in this association has been classified as suitable for irrigation. In addition to the small acreage of land involved, these irrigable lands commonly occur as small and irregular shaped tracts.

15. Stony Rockland association

This association, which is characterized by rough broken topography, very steep slopes, and rock outcrops, comprises an area of 237,610 acres, slightly more than nine percent of the county. It occurs mainly in the mountainous sections in the northern part of the county, with the largest area in the north-central part. Included are escarpments, steep canyon walls, rocky ridgetops, rock slides, rock ledges, and steep mountainous uplands, most of which are dominated by a complex of shallow

soils and rock outcrops. The soils, in addition to being shallow and highly variable, are usually stony and rocky. The exposed rocks consist of conglomerates, andesite, rhyolite, and shaley sediments, with lesser amounts of basalt and granite.

These steep mountainous and rocky lands support a wide variety of grasses, shrubs, and scrub trees. Many parts of this association, however, are only sparsely vegetated because of the steep slopes, thin soils, and rock outcrops. The escarpments, rock ledges, and steep slopes also tend to restrict the grazing by livestock. It does, however, provide a good habitat for many species of wildlife. Although there are a few open grassland areas on the ridgetops and in the narrow valleys, this association commonly has a thin overstory of oak, pinyon, and juniper trees. Some ponderosa pine grows on north facing slopes at the higher elevations. The more common grasses are blue grama, Arizona fescue, sideoats grama, bluestem, mountain muhly, mountain bromegrass, junegrass, pine dropseed, blue grass and little bluestem. Principal shrubs are oak brush, Apache plume, mountain mahogany, rabbitbrush, Sedges spp., and sahuista.

Soil Characteristics. Rockland, a miscellaneous land type, is dominant in this association. It consists of a complex of shallow soils and bedrock outcrops. Although shallow soils are the most extensive, small areas of moderately deep to deep soils are interspersed with the shallow soils, rock outcrops and ledges. The rock outcrops commonly occur as vertical or nearly vertical exposures and ledges. The rock outcrops commonly occur as vertical or nearly vertical exposures and ledges. The interspersed shallow soils are commonly stony and moderately coarse to medium-textured. Numerous stones and boulders are common over much of the land surface.

Rough broken land commonly occurs in those parts of this association where the land surface is covered by thick deposits of old alluvial sediments. These lands, which are usually steep to very steep and severely dissected, consist of a complex of shallow soils and exposures of unconsolidated to weakly consolidated sedimentary deposits. These old alluvial sediments are quite variable and consist dominantly of stratified clays, silts, sands, gravel and cobble. Some of the strata are occasionally cemented. The thin mantle of soil occurring between the outcrops is also highly variable. Gravelly and cobbly sandy loams and loams, however, are dominant.

Also in this association are soils of the Luzena and Cabezon series. Luzena soils have a thin brown

neutral cobbly loam surface layer and a brown to dark reddish-brown clay or gravelly clay subsoil. Igneous bedrock or conglomerate commonly occurs within 20 inches of the surface. Cabezon soils occur on strongly sloping and rolling ridge tops and fronts of lava flows. They have a surface layer of dark grayish-brown noncalcareous stony loam over a cobbly clay subsoil. This is underlain by basalt bedrock at depths ranging from 10 to 24 inches. The remaining parts of this association consist of small acreages of alluvial land, drainageways and arroyo bottoms, deep alluvial soils, and a number of unclassified soils. The unclassified soils are generally shallow, cobbly and stony. The deep alluvial soils, which commonly occur as small areas in valley bottoms adjacent to streams are dominantly moderately coarse to medium-textured.

Irrigation Potential. There is essentially no opportunity to develop irrigated land in this association. The dominance of shallow soils, together with rock outcrops, steep slopes, and rough broken topography preclude the use of this land for irrigation. The wide distribution and extremely small size of the deep alluvial soils that could be irrigated tend to preclude their use for irrigation.

16. Capillo-Tampico association

This association includes about 150,860 acres of mountainous land in the northeastern part of the county. The altitude ranges from about 7,000 to 10,000 feet, but is most commonly between 7,800 and 9,000 feet. It is characterized by mountainous topography that ranges from gently sloping to moderately steep on the ridge tops and valley areas to steep and very steep on mountain side slopes. The soils are developing in parent materials from mixed igneous and conglomerate rocks. They are typically dark-colored with a moderate to high content of organic matter and neutral to slightly acid in reaction. The surface layers are often gravelly and occasionally stony.

With the exception of the rockland component of this association, the soils are moderately productive and support good stands of native vegetation. The overstory vegetation consists generally of ponderosa pine, pinyon, juniper, and gambel oak, Douglas fir, white fir, and some spruce and aspen are on the north-facing slopes and at the higher elevations. Grasses include mountain muhly, mountain brome, junegrass, sideoats grama, blue grama, Arizona fescue, blue grass, pine dropseed, New Mexico needlegrass, and little bluestem. It

also supports a number of desirable browse plants that are suitable for grazing by wildlife.

Soil Characteristics. The soils in this association were not studied in detail, and those not named are described only broadly as unnamed soil groups.

Capillo soils are moderately deep, gravelly, and dark-colored. They occur on gently rolling uplands including the moderately steep side slopes of the upland ridges. These soils have a surface layer of dark brown neutral or slightly acid stony or gravelly loam. The subsoil is a brown gravelly clay loam or gravelly clay that is slightly acid to neutral in reaction. This is underlain at depths ranging from 20 to 40 inches by very gravelly soil materials weathered from conglomerate and mixed igneous rocks.

Tampico soils consist of deep dark-colored soils on steep mountain sides at elevations that generally range between 8,200 and 10,000 feet. They usually have a surface layer of dark brown neutral to slightly acid gravelly loam. Although the dark-colored surface layers commonly range from 6 to 12 inches in thickness, some soils have surface layers that are dark-colored to depths greater than 15 inches. The subsoil is a brown to dark brown neutral to slightly acid gravelly clay loam or gravelly loam. The gravel and cobble content typically increases significantly below a depth of three feet. These soils are underlain at depths of 48 to 60 inches or more by very gravelly alluvium, conglomerate, or mixed igneous rocks.

Raton-like soils are shallow and occur on rolling to hilly uplands and steep mountain side slopes. These soils have a surface layer of dark brown slightly acid to neutral gravelly loam over a brown gravelly or cobbly clay loam. The content of coarse fragments in these subsurface layers typically ranges from about 20 to 35 percent. However, in this unit, the content of coarse fragments varies considerably, and in nearly one-half of these soils it exceeds 35 percent. The depth to bedrock ranges from about 10 to 20 inches. Some rock outcrops occur along ridges, especially where slopes are steep or very steep.

Rockland, a miscellaneous land type, is also an important component of this association. It generally is steep and very steep, and consists of a complex of very shallow or shallow soils and outcrops of bedrock. The soils occurring as small areas or pockets of soil between the outcrops of bedrock are variable. They are, however, usually stony and gravelly with varying amounts of cobble, stones, and rocks on the surface.

The remaining parts of this association consist of moderately deep soils with thick dark-colored soils,

alluvial soils, and miscellaneous land types including rough broken land, drainage bottoms, and alluvial land. The moderately deep soils referred to are similar to those of group D, but differ in that they have thick very dark brown surface layers that extend to a depth of 16 to 24 inches or more.

Irrigation Potential. The rough broken and mountainous topography and steep slopes preclude the development of irrigation in this association. These soils are best used for forestry, range, recreation, and as watershed. The association provides a good habitat for many wildlife species.

17. Capillo-Raton-Weed association

This association, comprising an area of about 10,645 acres, occurs in the extreme northeastern part of the county, where it joins a similar and extensive area in Catron County. It is adjacent to soil association 16 and differs primarily from that association in that it is not as steep or as rough and broken. The mountainous landscapes, which occur at elevations ranging from about 7,000 to 8,500 feet, are gently sloping and undulating to moderately steep. The soils are dominantly shallow to moderately deep and are underlain by mixed igneous and conglomerate rocks. The surface layers are neutral to slightly acid in reaction and often gravelly and occasionally stony.

In general, it is a moderately productive unit, and, except for the small areas of rock outcrops, supports good stands of native vegetation. The overstory vegetation consists generally of ponderosa pine, pinyon, juniper, and gambel oak. Douglas fir, white fir, and some spruce and aspen are on the north-facing slopes. The more common grasses include mountain muhly, mountain brome, Junegrass, sidecoats grama, blue grama, Arizona fescue, blue grass, pine dropseed, New Mexico needlegrass, and little bluestem. It also supports a number of browse plants that are suitable for grazing by wildlife.

Soil Characteristics. The Capillo soils are moderately deep, gravelly, and dark-colored. These soils, which occur on gently rolling uplands and the moderately steep side slopes of upland ridges, have a surface layer of dark brown neutral or slightly acid gravelly or stony loam. The subsoil is a brown gravelly clay loam or gravelly clay that is slightly acid to neutral in reaction. This is underlain at a depth of 20 to 40 inches by very gravelly soil material weathered from conglomerate and mixed igneous rocks.

Raton-like soils are shallow and occur on rolling to hilly uplands and moderately steep mountain side slopes. These soils have a surface layer of dark brown slightly acid to neutral gravelly loam over a brown gravelly or cobbly clay loam. The content of coarse fragments in these subsurface layers usually ranges from about 20 to 35 percent. However, in this unit, the content of coarse fragments varies considerably, and, in approximately one-half of these soils, it exceeds 35 percent and may comprise as much as 70 percent of the soil mass. The depth to bedrock ranges from about 10 to 20 inches.

Weed soils are moderately deep, gravelly, and dark-colored, on gently rolling uplands. These soils have a thick dark grayish-brown neutral to slightly acid gravelly loam or gravelly sandy loam surface layer over a gravelly clay loam subsoil. A very gravelly substrata is usually encountered at depths of 20 to 36 inches. This in turn is typically underlain by conglomerate within a depth of 40 inches.

Suitability of Soils for Irrigation

The acreage of irrigable and non-irrigable land in each of the 17 soil associations is shown in table 5. The estimated acreage and percentage of land in each of the five classes were determined on the basis of the kinds of soils occurring in the soil associations.

The approximate distribution of the various land classes in Grant County is shown on the irrigation land class map (figure 2). This map is based on the soil association map (figure 1) and the acreages of land classes in each of the soil associations (table 5). The land class or classes shown in each area comprise more than 75 percent of the area. No land class was shown that did not comprise at least 15 percent of the area identified on the map. Where more than one land class is shown, the most extensive class is indicated first, followed in order by those of lesser extent. The small scale of the irrigation land class map precludes the possibility of showing small areas of land with different capabilities for irrigation. For example, the large and extensive areas of class 6 land may, and often do, contain small tracts of land suitable for irrigation. Because of the limitation of map scale, these small tracts that differ in capability for irrigation are not shown.

The irrigation land classes provided a relative rating of the suitability of land for irrigation. Class 1 land has few or no limitations for irrigation. The

Approximately 10 percent of this association consists of rockland. It commonly occurs on steep slopes and consists of a complex of shallow soils and outcrops of conglomerate or various types of igneous rock. The small soil areas intermingled with the outcrops of bedrock are highly variable and usually gravelly and stony. The remaining parts of this association consist of deep alluvial soils, rough broken land, drainage bottoms and alluvial land. The alluvial soils are usually dark colored and range from moderately coarse to moderately fine in texture. Small areas of these soils are also cobbly and stony.

Irrigation Potential. The only soils with characteristics suitable for irrigation are the deep alluvial soils. These soils are not extensive and are widely distributed, and they commonly occur as very small and irregular-shaped tracts, which will tend to preclude their use for irrigation. The lands in this association are therefore best used for forestry, range, recreation, and as watershed.

limitations for use of land under irrigation increase from 1 through 4, with class 4 having severe limitations. Class 6 land is non-irrigable. An analysis of the irrigation land classification data, shown in table 5 and figure 2, indicates that the potential for expansion of irrigation in Grant County occurs primarily in the following soil associations:

13. San Mateo-Shanta
3. Mohave-Stellar
2. Mimbres-Verhalen
4. Sonoita-Yturbide-Hap
1. Hondale-Mimbres

These six associations (figure 1) contain slightly more than 436,000 acres, or about 77 percent of the 569,595 acres of land classified as irrigable in this county. In addition, approximately 93 percent, or about 218,740 acres, of the classes 1 and 2 land occurs within these six associations.

The land in soil association 13, which occurs on the flood plains and adjacent terraces of the Gila and Mimbres rivers and tributaries, is well suited to irrigation. The already irrigated lands in Grant County are dominantly in this association, and are being successfully used for this purpose. Approximately 80 percent of the land in soil association 13 is in land classes 1 and 2 and is about equally

divided between these classes. Although the land in this soil area has a high capability for irrigation, the acreage available for expansion of irrigation is limited. A considerable part of the land within the boundaries of the San Mateo-Shanto association (13) is either already irrigated or being used for highways, roads, and small communities or built-up areas.

The Mohave-Stellar association (No. 3) offers the best potential for expansion of irrigation in this county. It contains about 31 percent (178,000 acres) of the land classified as suitable for irrigation in Grant County. The tracts of land suitable for irrigation are commonly large and contain little interspersed non-irrigable land. In general, it will require little leveling and conditioning in preparation for irrigation, because the soils usually occur on nearly level to very gently sloping landscapes. Approximately 34 percent of the land in this association has been placed in irrigation land class 1; 31 percent is in class 2; 25 percent is in class 3; 3 percent is in class 4, and the remaining 7 percent is non-irrigable or in class 6.

Although the Mimbres-Verhalen association (No. 2) is small (about 15,815 acres), it consists dominantly of land classified as suitable for irrigation. It occupies flood plains, valley bottoms, and swales contiguous to intermittent drainages in the southeastern part of the county. The susceptibility of much of the land in this unit to occasional flooding, or receiving runoff and seepage from higher lying lands, was the principal factor contributing to the placement of about 48 percent of the land in this association in class 2. The Verhalen soils were placed in class 3 primarily because of their extremely fine-textures and very slow permeabilities in addition to the factors previously discussed. Although there are some limitations in the use of these lands for irrigation, they merit consideration for this use. If provided with protection from flooding and with adequate irrigation systems, these lands should be able to support sustained irrigation under good systems of management.

The Sonoita-Yturbide-Hap association (No. 4), which is dominated by class 3 land (90 percent), is moderately well suited for use as irrigated cropland. The sandy textures with small to moderate amounts of gravel, limited moisture-retention capacity, and slope are the principal factors involved in the placement of these soils in class 3. Although these class 3 lands have moderate limitations for use as cropland under irrigation, there is a fair potential on the basis of the capability of the soils for development of irrigation. There is very little non-irrigable land in this unit, and, in

addition, the irrigable lands usually occur adjacent to the irrigable lands of the Mohave-Stellar association. This will further add to the possibility of developing relatively large and continuous tracts for irrigation.

Approximately 82 percent of the land in the Lonti-Poley-Pastura association (No. 8) has been classified as suitable for irrigation. Therefore, on the basis of the availability of suitable soils, it offers considerable potential for expansion of irrigation. This is particularly true of the large and extensive area of this association in the southern part of the county that joins the Mohave-Stellar association of both Grant and Luna counties. Although the class 3 lands (45 percent) in this unit have moderate limitations for use as cropland under irrigation, they undoubtedly will merit consideration for such use if they can be developed and used with the lands of higher capability in this unit, as well as that in the closely associated Mohave-Stellar association.

The Hondale-Mimbres association (No. 1), which occurs on nearly level to very gently sloping basin floors in the southern part of the county, also contains a relatively high percentage of land classified as suitable for irrigation. The potential for irrigation expansion, however, is not as favorable as in the Lonti-Poley-Pastura association, primarily because these soils are low, susceptible to poor drainage if irrigated, and some are saline and alkali-affected. These soil features were responsible for the classification of 61 percent of the land in this unit in irrigation land class 4; 30 percent in class 3; and 9 percent in class 6.

The Nickel-Upton-Tres Hermanos (No. 5) and Eba (No. 6) associations, which are identified on the irrigation land classification map by land class symbol "6-3", are dominated by non-irrigable lands. Approximately 71 percent of the land in these soils associations have been classified as class 6; 26 percent as class 3, and 3 percent as class 4. The gravelly and sloping soils of the Eba and Tres Hermanos series account for the majority of the land in class 3. Where these soils occur in areas of sufficient size, or where they can be developed with adjacent soils suitable for irrigation, they merit consideration for such use.

Although the Lonti-Rough Broken Land association (No. 10) contains an appreciable acreage of land classified as suitable for irrigation, the potential for development of land for such use in this unit is extremely limited. About 74 percent of the land in this association has been placed in class 6; 20 percent in class 4; and 6 percent in class 3. The Lonti soils, which account for the majority of the irrigable lands, are strongly sloping to rolling and

Table 5. Estimated acreage and approximate percentage of land in each irrigation land class by soil association, Grant County, New Mexico 1

Soil Map Symbol and Soil Association	Classes 1 to 4						Grand Total Acres Percent	Principal Limiting Factor(s)
	Class 1 Acres Percent	Class 2 Acres Percent	Class 3 Acres Percent	Class 4 Acres Percent	Total Acres Percent	Class 6 Acres Percent		
1 Hondale-Mimbres								
Hondale soils			6,328		6,328		6,328	Alkali; drainage; permeability
Mimbres soils		3,917			3,917		3,917	Alkali; drainage
Other soils		3,917	1,403		5,320		2,610	
Total		7,834	1,403		9,237		13,955	
2 Mimbres-Verhalen								
Mimbres silty clay loam	7,117				7,117		7,117	Overflow
Verhalen silty clay loam								Permeability; overflow; salinity
Other soils and land types	474	6,326			6,800		6,326	
Total	7,591	6,326			13,917		13,419	
3 Mohave-Sellar								
Mohave soils	55,596				55,596		57,512	Slope
Sellar soils	47,928				47,928		47,928	Permeability
Berino sandy loam	9,586				9,586		9,586	AWHC; soil depth; erosion
Forrest gravelly loam		9,586			9,586		9,586	AWHC; soil depth
Other soils and land types	9,886				9,886		9,886	AWHC; soil depth
Total	65,181	39,431			104,612		104,612	
4 Santa-Turkide-Hap								
Santa soils	2,389				2,389		2,389	AWHC; texture
Turkide soils	14,808				14,808		14,808	AWHC; texture
Hap gravelly loam	14,808				14,808		14,808	AWHC; slope; texture
Other soils and land types	592	2,369			2,961		2,961	
Total	2,961	53,308			56,269		59,230	
5 Nickel-Upton-Trees Hermamos								
Nickel gravelly sandy loam								
Upton gravelly loam								
Trees Hermamos gravelly clay loam	15,687				15,687		23,531	AWHC; soil depth
Other soils and land types	5,490				5,490		19,609	AWHC; soil depth
Total	21,177	27			21,204		15,687	AWHC
6 Eba								
Eba very gravelly loam		843			843		54,905	Soil depth; AWHC
Sonotsa gravelly sandy loam							78,435	AWHC; texture
Other soils and land types	56				56		56	
Total	56	843			899		92	**
7 Rockland-Lehmanns								
Rockland								
Lehmanns rocky loam								
Other soils and land types								
Total								
8 Lonti-Poley-Pastura								
Lonti gravelly loam	61,356				61,356		87,620	Topography; soil
Poley gravelly loam	43,156				43,156		61,322	AWHC; soil depth
Pastura gravelly loam							26,281	
Other soils and land types	3,452	25,894			29,346		26,281	
Total	3,452	68,113			71,565		175,205	

commonly occur as small areas intermingled with extensive areas of land classified as non-irrigable. Because of these features the lands in this association undoubtedly will merit little consideration for irrigation.

In the remainder of the soil associations, the amount of irrigable land ranges from little or none in soil associations 7, 11, 14, 15, 16, and 17 to about 20 percent in associations 9 and 12. The characteristics of the soils and related land features in these soil associations are such that there is little

or no opportunity of development for irrigation. The acreage of soils classified as suitable for irrigation commonly occurs as small tracts that are widely distributed and intermingled with large areas of non-irrigable lands. These features will generally preclude their use for irrigation.

Of the 569,595 acres of land in Grant County classified as suitable for irrigation, about 15 percent is class 1, 26 is class 2; 44 percent is class 3, and 15 percent is class 4.

Suitability of Soils for Engineering

In this section information is provided on engineering properties and uses of soils as construction material and as a support for various kinds of structures. The information provided is in tabular form and in accordance with soil associations shown on the small-scale soil map (figure 1). Selected engineering properties, engineering classifications, and estimates on the suitability of soils for specified engineering uses are indicated for the major soils in each soil association. This correlation of engineering data and soil properties according to soil associations or general soil areas can be useful in estimating the suitability of certain areas for engineering purposes. The information on general soil problems, limitations, and hazards can also be helpful in the selection of areas for various engineering structures or practices.

The data presented here will not eliminate the need for on-site sampling and testing of sites for design and construction of specific engineering works and uses. This is particularly true at those sites of specific engineering works involving heavy loads or where excavations are deeper than the soil depths reported here. In addition, the general soil map does not specifically show the location of the individual kinds of soil.

The general soil map is useful, however, for planning more detailed investigations and for suggesting the kinds of problems that may be expected in each of the soil associations.

Engineering Soil Groups and Estimated Soil Properties

Estimates of selected soil properties and engineering groups of importance in engineering are given in table 6. Information taken from detailed soil surveys, knowledge of the soil types of the county, and a limited amount of laboratory test

data were used as a basis for making these estimates.

A brief explanation of some of the terms used in table 6 follows:

The "USDA texture" is determined by the relative proportions of sand, silt, and clay in the soil mass. It is the standard system used by the U.S. Department of Agriculture to classify soils according to texture.

Highway engineers generally classify soil materials according to the system approved by the American Association of State Highway Officials.⁸ In this system (AASHO), classification is based on the gradation, liquid limit, and plasticity index of the soil. Highway performance has been related to this system of classification. All soil materials are classified in seven principal groups. The groups range from A-1 (gravelly soils of high bearing capacity, the best soils for subgrades) to A-7 (clay soils having low strength when wet, the poorest soils for subgrades).

Many engineers prefer to use the Unified soil classification system established by the Waterways Experiment Station, Corps of Engineers.⁹ This system is based on identification of soils according to their texture and plasticity and their performance as engineering construction materials. Soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic.

The estimated percentage of soil material passing sieves No. 4, No. 10 and No. 200 is in the columns headed by these sieve numbers. The percentage of materials as given reflects the normal range for the

⁸ American Association of State Highway Officials, 1955 Standard Specifications for Highway Materials and Methods of Sampling and Testing. Ed. 7, part 1, 257 pp., illus.

⁹ Waterways Experiment Station, Corps of Engineers. 1953 the Unified Soil Classification System. Tech. Memo. 3-357. 2V. and appendix.

Table 6. Engineering soil groups and estimated soil properties, Grant County, New Mexico

Soil Map Symbol and Soil Association	Depth from Surface in.	USDA texture	Classification Unified	AASHTO	Percentage Passing Sieve--			Shrink-swell Potential	
					No. 4 (4.75mm)	No. 10 (2.0mm)	No. 200 (0.075mm)		
								Range in Permeability in/hr	
1 Hondaie-Mimbres									
Hondaie	0-7	Silt loam	ML or CL	A-4 or A-6	100	100	55-75	0.20-0.63	Moderate
.	7-13	Clay	CL or CH	A-6 or A-7	100	100	65-95	< 0.20	High
.	13-30	Silty clay loam	CL	A-6	100	100	60-85	< 0.20	Moderate to high
.	30-60	Sandy clay loam (stratified)	SC	A-6	90-100	98-100	35-55	< 0.20	Moderate
Mimbres	0-42	Silty clay loam	CL	A-6 or A-7	100	100	85-95	0.20-0.63	Moderate
.	42-60	Sandy clay loam	SC	A-6	100	100	35-50	0.63-2.50	Low
2 Mimbres-Verdalen									
Mimbres	(See association 1)								
Verdalen	0-5	Silty clay loam	CL or MH-CH	A-6	100	100	75-95	0.20-0.63	Moderate
.	5-60	Clay	CH	A-7	100	100	75-95	< 0.20	High
3 Mohave-Stellar									
Mohave	0-8	Sandy clay loam	SM	A-4	100	100	30-45	0.63-2.50	Low
.	8-42	Clay loam	CL	A-6	100	100	60-70	0.20-0.63	Moderate
.	42-60	Sandy clay loam and sandy loam	SC or SM	A-6 or A-4	100	100	30-55	0.63-2.50	Low
Stellar									
.	0-5	Silty clay loam	CL	A-6	100	100	70-80	0.20-0.63	Moderate
.	5-23	Clay loam	CL	A-7	100	100	70-95	< 0.20	High
.	23-60	Clay loam	CL	A-6	100	100	60-75	0.20-0.63	Moderate
Berizo									
.	0-10	Sandy loam	SM	A-2	100	100	25-35	2.50-6.30	Low
.	10-36	Sandy clay loam	SC	A-6	100	100	35-45	0.63-2.50	Low to moderate
.	36+	More than 15% CaCO ₃							
Forrest									
.	0-4	Gravelly loam	SM	A-4	85-95	75-85	30-40	0.63-2.50	Low
.	4-30	Gravelly clay	MH	A-7-5	90-100	75-90	60-75	0.20-0.63	High
.	30-40	Very gravelly clay loam	GC	A-2-6	40-60	25-45	15-25	0.20-2.50	Low
4 Sonolita-Yurbide-Hap									
Sonolita	0-5	Gravelly sandy loam	SM	A-2	75-90	70-85	20-30	2.50-6.30	Low
.	5-30	Gravelly sandy clay loam	SC	A-4	75-90	70-85	35-45	0.63-2.50	Low
.	30-60	Gravelly sandy loam	SM	A-2	70-85	65-85	20-35	2.50-6.30	Low
.	60-80	Loamy sand	SM	A-2	95-100	98-100	15-30	2.50-6.30	Low
.	8-21	Gravelly loamy sand	SM	A-2	75-85	75-85	10-25	> 6.30	Low
.	21-60	Gravelly sand	SW	A-1	70-85	70-85	10-20	> 6.30	Low
.	3-28	Gravelly sandy clay loam	SC	A-6	75-85	70-85	35-45	0.63-2.50	Moderate
.	28-38	Gravelly sandy clay loam	SC	A-6	75-85	70-85	35-45	0.63-2.50	Moderate
.	38-50	Gravelly sandy clay loam	SC	A-6	70-85	65-80	35-45	0.63-2.50	Moderate
5 Nickel-Upton-Trees Hermosos									
Nickel	0-14	Gravelly sandy loam	SM	A-2 or A-4	75-85	70-85	20-45	2.50-6.30	Low
.	14-60	Very gravelly loam	GM	A-1	35-50	35-50	> 6.30	Low	
.	0-8	Gravelly loam	SM	A-2 or A-4	85-75	80-65	25-40	0.63-2.50	Low
.	8	Gravelly caliche, upper part strongly cemented							
.	8-27	Gravelly clay loam	CL	A-6	75-85	70-80	40-50	0.20-0.63	Moderate
.	24-45	Very gravelly loam	GM	A-2	35-50	35-50	25-30	2.50-6.3	Low

Table 6. Continued

Soil Map Symbol and Soil Association	Depth from surface in.	USDA texture	Classification Unified	AASHTO	Percentage Passing Sieve--			Range in Permeability in/hr	Shrink-swell Potential
					No. 4 (4.75mm)	No. 10 (2.0mm)	No. 200 (0.075mm)		
6 Eba	0-5	Very gravely clay loam	GM	A-2-4	35-50	35-50	25-40	0.63-2.50	Low
	5-31	Very gravely clay	GC	A-6	25-50	25-45	20-40	0.20-0.63	Moderate
	31-50	Very gravely clay loam	GC	A-2-6	25-50	25-40	15-30	0.20-2.50	Low
	0-5	Gravely sandy loam	SM	A-2	75-90	70-85	20-30	2.50-6.30	Low
	5-42	Gravely sandy clay loam	SM	A-4	75-90	70-85	35-50	0.63-2.50	Low
	42-60	Gravely sandy loam	SC	A-2	75-85	65-85	20-40	2.50-6.30	Low
7 Rockland-Lehman									
Rockland		(A miscellaneous land type - no estimates made)							
Lehman	0-8	Stony clay	GM	A-2 or A-4	40-45	35-55	25-45	0.20-0.63	Moderate
	8-15	Stony clay	CL	A-7	65-85	60-80	45-70	0.20-0.63	Moderate
8 Lontl-Poley-Pastura									
Lontl	0-4	Gravely loam	ML	A-2 or A-4	85-95	75-85	45-60	0.63-2.50	Low
	4-40	Gravely clay	CL	A-7	85-95	70-85	55-65	0.20-0.63	Moderate
	40-60	Gravely sandy clay loam	SC	A-2	75-85	65-85	45-60	0.63-2.50	Low
Poley	0-5	Gravely loam	ML	A-2 or A-4	85-95	75-85	45-60	0.20-0.63	Moderate
	5-28	Cobbly clay	CL	A-7	85-95	70-85	55-65	0.63-2.50	Low
	28+	Cobbly caliche; weakly cemented in upper part	CL	A-7	85-95	70-85	55-65	0.63-2.50	Moderate
Pastura	0-8	Gravely loam	ML	A-4	65-80	60-75	35-50	0.63-2.50	Low
	8+	Strongly cemented caliche	ML	A-4	65-80	60-75	35-50	0.63-2.50	Low
9 Rough Broken Land-Lontl									
Rough broken land		(No estimates made - properties variable)							
Lontl		(See association 8)							
10 Lontl-Rough Broken Land									
Lontl	0-4	Gravely loam	ML	A-2 or A-4	80-95	65-85	40-50	0.63-2.50	Low
	4-35	Gravely clay	CL	A-7	80-95	65-85	50-60	0.20-0.63	Moderate
	35-60	Gravely sandy clay loam	SC	A-4	75-90	60-80	15-40	0.63-2.50	Low
Rough broken land		(No estimates made - properties variable)							
11 Luzena-Arp									
Luzena	0-3	Cobbly loam	ML	A-2 or A-4	80-95	65-85	40-50	0.63-2.50	Low
	3-15	Gravely clay	CL	A-7	80-95	70-90	55-65	0.20-0.63	Moderate
	15-20	Gravely clay loam	ML-CL	A-6	75-90	65-80	45-55	0.20-2.50	Low
Arp	0-4	Gravely loam	ML	A-2 or A-4	80-95	65-85	40-50	0.63-2.50	Low
	4-24	Gravely clay loam	ML-CL	A-6	75-90	65-85	50-60	0.20-0.63	Moderate
	24-30	Very gravely clay loam	GC	A-2-6	40-60	35-45	35-45	0.20-2.50	Low
	30+	Bedrock							
12 Cabazon-Thunderbird									
Cabazon	0-3	Stony loam	GM	A-4	45-55	40-50	20-40	0.63-2.50	Low
	3-12	Clay	CH or CL	A-7 or A-6	90-100	75-90	75-90	< 0.20	High
	12+	Basalt bedrock							
Thunderbird	0-5	Stony clay loam	CL	A-6	85-95	80-90	60-75	0.63-2.50	Moderate
	8-30	Cobbly clay	CL or CH	A-6 or A-7	75-90	70-85	65-80	< 0.20	High
	30+	Basalt bedrock							
Basalt rockland		(No estimates made - properties variable)							

Table 6. Continued

Soil Map Symbol and Soil Association	Depth from Surface in.	USDA texture	Classification Unified	AASHTO	Percentage Pausing Sieve--			Range in Permeability in/hr	Shrink-swell Potential
					No. 4 (4.75mm)	No. 10 (2.0mm)	No. 200 (0.074mm)		
13 San Mateo-Santa									
San Mateo	0-12	Loam	ML	A-4	100	100	60-75	0.63-2.50	Low
	12-30	Stratified loam:silt:clay	ML or CL	A-4 or A-6	100	100	35-85	0.63-2.50	Low to moderate
Santa	0-9	Loam	ML or CL	A-4 or A-6	95-100	90-100	30-65	0.63-2.50	Low to moderate
	9-30	Loam or light clay loam	ML or CL	A-4 or A-6	95-100	90-100	35-85	0.63-2.50	Low to moderate
Glenburg-like	0-10	Fine sandy loam	SM	A-2	100	100	40-55	2.90-6.30	Low
	10-30	Stratified loam and sandy loam	ML or CL	A-4	100	100	45-75	0.63-2.50	Low
14 Rockland-Luzern-Santa									
Rockland	(No estimates made - properties variable)								
Luzern	(See association 11)								
Santa	0-12	Stony loam	GM	A-4	55-70	50-65	30-50	0.63-2.50	Low
15 Sharp Rockland Association									
Rockland	(No estimates made - properties variable)								
Luzern	(See association 11)								
Cabazon	(See association 12)								
16 Capillo-Tampico									
Capillo	0-10	Gravelly loam and stony loam	GM or ML	A-4	55-70	50-65	30-50	0.63-2.50	Low
	10-30	Gravelly clay	CL	A-6	70-85	65-85	50-75	0.20-0.63	Moderate
	30+	Conglomerate and mixed igneous rocks							
Tampico	0-12	Gravelly loam	ML	A-4	75-85	70-85	30-40	0.63-2.50	Low
	12-36	Gravelly clay loam	ML or CL	A-4 or A-6	70-85	65-85	50-75	0.63-2.50	Low to moderate
Raton-like	0-15	Gravelly clay loam	ML or CL	A-4	65-80	60-80	50-75	0.63-2.50	Low
	15+	Igneous bedrock							
17 Capillo-Raton-Weed									
Capillo	(See Capillo-Tampico association)								
Raton-like	(See Capillo-Tampico association)								
Weed	0-10	Gravelly loam	ML	A-4	75-85	70-85	30-40	2.50-6.30	Low
	10-24	Gravelly clay loam	ML or CL	A-4 or A-6	70-85	65-85	50-75	0.63-2.50	Low
	24-36	Very gravelly loam	GM	A-2	50-65	45-60	20-45	2.50-6.30	Low
	36+	Conglomerate							

Table 7. Interpretation of soil properties for engineering uses, Grant County, New Mexico

Soil Map Symbol and Soil Association	Suitability as a Source of --		Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential (untreated steel pipe)
	Topsoil	Roadfill		
1 Hondale-Mimbres Hondale silt loam	Poor; often alkali affected	Poor; very unstable; moderate to high shrink-swell	Severe; very slow permeability	High
Mimbres silty clay loam	Surface 8 to 10 inches fair; clayey	Poor; moderately plastic materials	Severe; slow permeability	Moderate
2 Mimbres-Verhalen Mimbres silty clay loam	(See association 1)			
Verhalen silty clay loam	Poor; clayey material	Poor; plastic material	Severe; very slow permeability	High
3 Mohave-Stellar Mohave sandy clay loam	Surface 6 to 8 inches fair to good	Fair; moderate shrink-swell	Severe; slow permeability; substratum occasionally moderately permeable	Moderate
Stellar silty clay loam	Poor; clayey material	Poor; plastic; high to moderate shrink-swell	Severe; slow permeability	Moderate
Berino sandy loam	Fair; sandy and erodible	Fair material when mixed to a depth of about 3 feet	Moderate; moderately permeable	Moderate
Forrest gravelly loam	Surface 4 to 5 inches fair; poor below; gravelly	Poor to a depth of 30 inches; good below 30 inches	Moderate; moderately permeable substratum	Low
4 Sonoita-Yturbide-Hap Sonoita gravelly sandy loam	Poor; erodible; moderate to high content of fine gravels	Fair to a depth of about 30 inches; good below 30 inches	Slight	Low
Yturbide loamy sand	Poor; sandy and erodible	Good	Slight	Low
Hap gravelly loam	Surface 5 to 10 inches fair; moderate gravel content	Fair; moderate shrink-swell	Moderate; moderately permeable	Moderate
5 Nickel-Upton-Tres Hermanos Nickel gravelly sandy loam	Poor; high gravel content	Good	Slight	Low to moderate
Upton gravelly loam	Poor; calcareous and gravelly	Good; caliche at 6 to 20 inches; may require crushing	Severe; shallow to strongly cemented caliche	Moderate
Tres Hermanos gravelly loam	Poor; calcareous and gravelly	Upper 2 feet fair; good below 2 feet	Slight	Low
6 Eba Association Eba very gravelly loam	Poor; excessive gravel	Fair to good	Moderate to severe; caliche and slow permeability	Low
Sonoita gravelly sandy loam	Poor; erodible; moderate to high content of fine gravel	Fair to a depth of about 30 inches; good below 30 inches	Slight	Low
7 Rockland-Lehmans Rockland	(Interpretations not made)			
Lehmans rocky loams	Poor; stony and clayey	Poor; limited amount of material; plastic; stones	Severe; shallow to bedrock	Moderate

Soil Features Affecting--

Foundation support	Highway location	Soil Features Affecting--			Terraces, diversions, contour furrows and pitting
		Reservoir area	Farm ponds Embankment		
Fair bearing capacity; moderate to high shrink-swell	Unstable and plastic material	*	Poor stability; subject to cracking; erodible	Unstable embankments; channels subject to siltation; difficult to vegetate	
Fair bearing capacity; moderate to high shrink-swell	Plastic material; subject to occasional flooding	*	Clayey material; subject to cracking	Exposed subsoil material clayey and difficult to vegetate	
Poor to fair bearing capacity and shear strength; high shrink-swell	Plastic and unstable material	*	Clayey material; subject to cracking; difficult to vegetate	Subject to cracking and piping	
Fair bearing capacity and shear strength; low to moderate shrink-swell	Fair bearing capacity; other features favorable	Good with compaction	Stable material when compacted	*	
Fair to poor bearing capacity and shear strength; moderate to high shrink-swell	Plastic material; fair to poor bearing capacity	*	Clayey material; subject to cracking	Exposed subsoil material clayey and difficult to vegetate	
Good bearing capacity and shear strength; low to moderate shrink-swell	Erodible on exposed embankments; other features favorable	Moderately permeable; may require compaction	Erodible; fair stability when mixed and compacted	Surface layers sandy and erodible	
Good bearing capacity and low shrink-swell below a depth of 30 inches	Plastic and gravelly material to a depth of about 30 inches	May expose very gravelly and permeable layers below 30 inches	Gravelly and clayey materials; fair stability when compacted	Moderate slopes; clayey subsoil	
Good bearing capacity and shear strength; low shrink-swell	Some undulating slopes; other features favorable	Subject to seepage; rapidly permeable	Gravelly, permeable, and erodible material; fair stability if compacted	Erodible and permeable material	
Good bearing capacity and shear strength; low shrink-swell	Subject to wind erosion; some drifting sand	Material too porous to hold water	Erodible and very permeable	**	
Good bearing capacity and shear strength; moderate shrink-swell	Moderately sloping; some cuts and fills; moderate shrink-swell	Moderately permeable; may require compaction or sealing	Moderately erodible; fair stability if compacted	Moderate slopes; subject to channel erosion	
Good bearing capacity and shear strength; low shrink-swell	Moderately sloping; some cuts and fills	Subject to seepage; permeable and gravelly	Gravelly and cobbly material; fair stability if compacted	Moderate slopes; gravelly and cobbly material; difficult to vegetate	
Good bearing capacity; shallow to caliche; strongly cemented in upper part	Moderately sloping; some cuts and fills; strongly cemented caliche at 6 to 20 inches	**	Very calcareous and gravelly material; difficult to vegetate	**	
Good bearing capacity; low shrink-swell	Some undulating slopes; other features favorable	Gravelly and permeable material below a depth of 24 to 30 inches	Gravelly and cobbly material; fair stability if compacted	Undulating slopes; moderate gravel and cobble content; difficult to vegetate	
Good bearing capacity and shear strength; low to moderate shrink-swell	Moderate slopes; some cuts and fills	Subject to seepage; excessive amount of coarse fragments in substratum	Excessive coarse fragments; ** fair stability if compacted	**	
Good bearing capacity and shear strength; low shrink-swell	Some undulating slopes; other features favorable	Subject to seepage; rapidly permeable	Gravelly, erodible and permeable material; fair stability if compacted	Erodible and permeable; fairly stable if compacted	
Shallow to bedrock	Steep slopes; rock outcrops; limited amount of borrow material	**	Limited amount of material; clayey and stony	**	

*Soil features favorable

**Unsuitable or practice not applicable

Table 7. Continued

Soil Map Symbol and Soil Association	Suitability as a Source of--		Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential (untreated steel pipe)
	Topsail	Roadfill		
8 Lonti-Poley-Pastura Lonti gravelly loam	Fair to a depth of 6 to 8 inches; gravelly	Poor; clayey and plastic subsoil	Moderate; moderately permeable below 40 inches	Moderate
Poley gravelly loam	Fair to a depth of 6 to 8 inches; gravelly	Poor; clayey and plastic subsoil; fair below 30 inches	Severe; slowly permeable	Moderate
Pastura gravelly loam	Poor; thin surface layer with gravel	Good; limited material; unless caliche is crushed	Severe; shallow to cemented caliche	Moderate
9 Rough Broken Land-Lonti Rough broken land	(Interpretations not made)			
Lonti gravelly loam	Fair to a depth of 6 to 8 inches; gravelly	Poor; clayey and plastic subsoil	Moderate; moderately permeable below 40 inches; sloping	Moderate
10 Lonti-Rough Broken Land Lonti gravelly loam	Poor to a depth of 6 to 8 inches; gravelly	Poor; clayey and plastic subsoil	Moderate; sloping; permeable below 40 inches	Moderate
Rough broken land	(Interpretations not made)			
11 Luzena-Arp Luzena cobbly loam	Poor; thin cobbly and stony surface layer	Poor; limited amount of material; plastic; cobbly	Severe; shallow to bedrock	Low to moderate
Arp gravelly loam	Poor; gravelly; very thin surface layer	Fair to good; bedrock at 20 to 40 inches	Severe; moderately steep slopes; bedrock at 20 to 40 inches	Slight to moderate
12 Cabezon-Thunderbird Cabezon stony clay loam	Poor; stony	Poor; plastic and stony; limited amount of material	Severe; shallow to bedrock	Moderate to low
Thunderbird stony clay loam	Poor; stony; clayey at 5 to 8 inches	Poor; plastic; some stones	Severe; moderately deep to bedrock	Moderate to low
13 San Mateo-Shanta San Mateo loam	Good	Fair to poor	Slight to moderate; flooding may be a problem	Moderate
Shanta loam	Good to a depth of 18 to 20 inches	Fair to poor	Moderate; occasional flooding; permeability	Moderate
Glenberg-like fine sandy loam	Fair; sandy	Fair	Slight; flooding may be a problem	Moderate
14 Rockland-Luzena-Santana Rockland	(No interpretations made)			
Luzena cobbly loam	Poor; thin cobbly and stony surface layer	Poor; limited amount of material; plastic; cobbly	Severe; shallow to bedrock	Low to moderate
Santana stony loam	Poor; gravelly and stony	Limited amount of material; stony	Severe; shallow to bedrock; steep slopes	Low to moderate
15 Stony Rockland Rockland	(No interpretations made)			
Rough broken land	(No interpretations made)			
Luzena cobbly loam	(See association 14)			
Cabezon stony loam	Poor; stony and cobbly	Poor; limited amount of material; stony	Severe; shallow to bedrock	Low to moderate

Soil Features Affecting--

Foundation support	Highway location	Soil Features Affecting--			Terraces, diversions, contour furrows and pitting
		Reservoir area	Farm ponds	Embankment	
Fair bearing capacity and shear strength; moderate to high shrink-swell	Clayey and plastic subsoil	Subject to seepage if excavation extends below 40 inches	Clayey subsoil; poor compaction characteristics		Clayey subsoil; difficult to work and vegetate
Fair bearing capacity and shear strength; moderate shrink-swell	Cobbly caliche below 30 inches; difficult to vegetate if exposed	Subject to seepage if excavation below a depth of 30 inches	Clayey subsoil; cobbly caliche below a depth of 30 inches		Clayey subsoil; difficult to work and vegetate
Shallow to caliche with good bearing capacity	Shallow to cemented caliche	Subject to seepage; shallow to caliche	Limited amount of borrow materials; exposed caliche material difficult to vegetate		**
Fair bearing capacity and shear strength; moderate to high shrink-swell	Moderately steep and rolling topography	Subject to seepage if excavation extends below 40 inches; steep slopes	Clayey subsoil; poor compaction characteristics		Generally not suitable because of topography
Fair bearing capacity and shear strength; moderate to high shrinkswell	Moderately steep and hilly topography	Subject to seepage if excavation extends below 40 inches	Clayey subsoil; poor compaction characteristics		Generally not suitable because of topography
Bedrock within 20 inches of the surface	Rolling and hilly topography; some steep breaks and canyon walls	**	Limited amount of material; clayey and cobbly		**
Bedrock at 20 to 40 inches; good to fair bearing capacity above bedrock	Rolling to hilly topography; bedrock at 20 to 40 inches	**	Gravelly material; bedrock at 20 to 40 inches		**
Shallow to bedrock	Shallow to bedrock; some sloping areas; stony	**	Stony; limited amount of material; plastic		**
Moderately deep to bedrock; high shrink-swell and fair bearing capacity above bedrock	Clayey subsoil layers with poor bearing value	Moderately deep to bedrock; subject to seepage if bedrock exposed	Clayey materials with poor compaction characteristics		Stony; dense clayey subsoil layers
Fair to good bearing capacity and shear strength; stratified materials	Occasional overflow hazard; few wet areas	Soil features generally favorable; some sandy strata may require sealing	Stable material when mixed and compacted		*
Fair to poor bearing capacity and shear strength	*	May require compaction; moderate to moderately slow permeability	Moderate content of organic matter in surface layers		*
Fair to good bearing capacity; stratified materials	Occasional overflow hazard; other features favorable	Subject to seepage; sandy strata may require sealing	Erodible; fair stability when mixed and compacted		*
Bedrock within 20 inches of surface	Rolling and hilly topography; some steep breaks and canyon walls	**	Limited amount of material; clayey and cobbly		**
Bedrock within 20 inches of surface	Steep slopes; some rock outcrops; very steep canyon walls and breaks	**	Limited amount of material; stony		**
Bedrock at 10 to 24 inches	Stones; plastic shallow to bedrock; some outcrops	**	**		**

Table 7. Continued

Soil Map Symbol and Soil Association	Suitability as a Source of --		Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential (untreated steel pipe)
	Topsoil	Roadfill		
16 Capillo-Tampico Capillo gravelly loam	Poor; gravelly and stony	Poor; plastic; moderate content of stones and gravel	Severe; bedrock at 20 to 40 inches; slopes	Low to moderate
Tampico gravelly loam	Fair; gravelly	Fair	Severe; steep slopes	Low
Raton-like gravelly clay loam	Poor; thin gravelly and cobbly surface layer	Fair; limited amount of borrow material	Severe; shallow to bedrock; steep slopes	Low
17 Capillo-Raton-Weed Capillo gravelly loam	(See association 16)			
Raton-like gravelly clay loam	(See association 16)			
Weed gravelly loam	Fair; gravelly	Fair	Moderate to severe--depending on slope	Low

soil series, and most soils within a series will fall within the range indicated.

Permeability as indicated in Table 6 relates to the rate water moves through undisturbed and uncompacted soil. The estimates are based on the texture, structure, and porosity of the soil.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

Engineering Interpretations

Table 7 indicates the relative suitability of soils to support various structures, to serve as construction materials for highways, farm facilities, and other engineering structures, to absorb sewage effluent, and to serve for other engineering purposes. Also listed are soil features or properties that might present difficulties or affect such uses. Although soil features restricting the use of soils for various engineering structures are emphasized, favorable soil features may also be listed. The ratings and other interpretations in this table are based on the estimated soil properties for engineering uses as listed in Table 6, on available test data, and field experience.

Topsoil is a term used to designate a fertile soil

or soil material of favorable texture, structure, and organic matter content used as topdressing for lawns, roadbanks, and various other engineering structures. The ratings of poor, fair, or good indicate the general suitability of the surface soil layers for such use.

Suitability ratings of poor, fair, or good for road fill are given for the major soils in each soil association. The ratings are based on the performance of the soil material when excavated and used as borrow for highway subgrade.

Sewage filter fields are affected mainly by permeability, depth to water table, depth to bedrock or indurated caliche, and susceptibility to flooding. The degree of limitations and principal reasons for assigning moderate or severe limitations are given.

A corrosion potential of low, moderate, or high is indicated for the major soils in each soil association. Corrosivity, as used here, indicates the potential danger of uncoated steel pipe to corrode or become weakened through chemical action. Among the features considered in rating corrosion potential are soil drainage, presence of soluble salts, and frequency of wetting and drying. The texture, structure, and porosity of the soil are also important because of their effect on aeration, moisture-holding capacity, and movement of water.

In the remainder of the columns in Table 7 are given the major soil features or properties that affect the use of a soil for specified purposes. For example, under the column headed "Foundation

Foundation support	Highway location	Soil Features Affecting--			Terraces, diversions, contour furrows and pitting
		Farm ponds		Embankment	
		Reservoir area			
Subsoil has poor to fair bearing capacity; conglomerate or bedrock at 20 to 40 inches	Moderately steep and hilly topography	**	**	**	
Fair bearing capacity; conglomerate or bedrock at 48 to 60 inches	Steep slopes and hilly topography	Steep and hilly topography subject to seepage	Fair stability if compacted; gravelly	**	
Bedrock within 20 inches of surface	Steep slopes and hilly topography; shallow to conglomerate and bedrock	**	**	**	
Good bearing capacity and fair shear strength	Moderately steep and rolling topography	Very permeable substrata; subject to seepage	Fair stability; substratum very gravelly and porous material	**	

**Unsuitable or practice not applicable

Support" are listed those features of the undisturbed soil that influence its capacity to support low buildings with normal foundation loads. Although specific values of bearing capacity and shear strength are not assigned, general values are indicated.

Highway location is influenced by features of the undisturbed soil that affect construction and maintenance of highways. The soil features considered include the depth to bedrock and caliche, the content of stones and rocks, the suitability for embankments, susceptibility to overflow, erodibility, stability, ease of excavation and hauling, salinity, plasticity, and topography. The more common soil features affecting highway construction and maintenance are listed in the column headed "Highway Location".

The soil features that affect seepage or loss of water from excavated reservoir sites are those considered under farm pond reservoir areas. The permeability, depth to bedrock or caliche, and possibility of exposing porous strata are some of the items listed.

Farm pond embankments serve as dams. The major soil features, of both subsoil and substratum, that are of importance in the use of soils for constructing embankments are considered.

Terraces and diversions are low structures designed to retain or direct water. Pitting, chiseling, and contour furrowing serve to loosen the soil and retain water from rainfall and snow melt. The intake rate, permeability, stability of clods, and the use of the soil material for embankments are the soil features considered.

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