SOIL ASSOCIATIONS AND LAND CLASSIFICATION FOR IRRIGATION MORA COUNTY

Agricultural Experiment Station
in cooperation with
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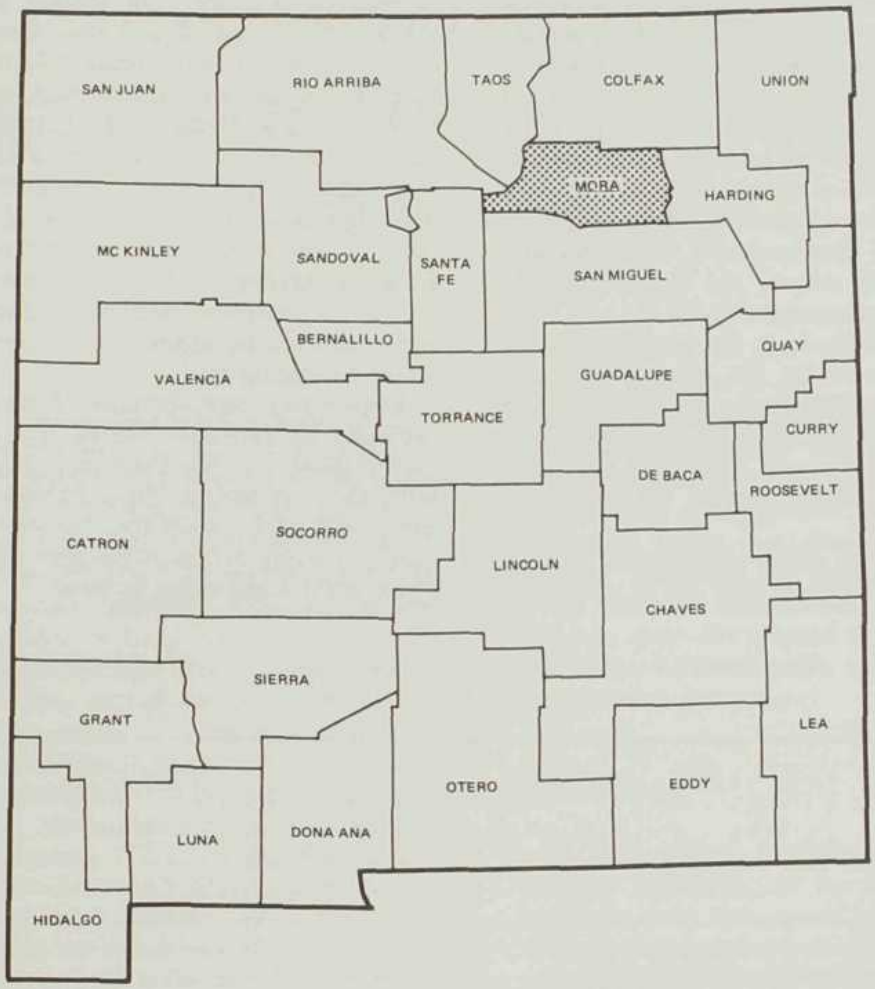

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Summary

Mora County has a land area of 1,244,200 acres, of which 49 percent is considered suitable for irrigation. Of this estimated acreage of irrigable land, about 18,000 acres are now irrigated. Therefore, a large acreage 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 82,738 acres are in irrigation land class 1; 263,648 acres in class 2; 76,162 acres in class 3; and 185,969 acres in class 4. The remaining 635,683 acres in the county are in land class 6, which is not suitable for irrigation.

The data are presented on the basis of the 17 soil associations shown on the general soil map (figure 1). The irrigation land classification map (figure 2) shows the approximate distribution of land classes in Mora 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 Rockland-Stony Land association (No. 10) is generally restricted to recreation use, grazing and habitat for wildlife, and limited grazing for livestock. In contrast, the Colmor-Swastika-Berthoud (No. 3) and LaBrier-Manzano-Loma (No. 4) are suitable for many uses, including irrigated farming, range, urban and industrial sites, recreation, and as habitat for many species of wildlife. The high mountainous land in soil associations 12, 13, 14, and 15 includes the principal timber-producing soils in the area. These associations also provide livestock grazing and a good habitat for many species of wildlife, and offer many recreational opportunities. In addition, they include important water-producing lands.

Engineering classification of these soils is also provided 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 MORA COUNTY

H.J. Maker[1], G.W. Anderson[2], and J.U. Anderson[1]

An essential for planning the best possible use of land and water resources in New Mexico is information on the capability of soils for the numerous uses, present and potential. One such land use is irrigated agriculture, and it is important that the many kinds of soil within New Mexico 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 Mora 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 operations. 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 Mora County are presented in the map showing land classification for irrigation (figure 2). The general soils map (figure 1) and a few detailed soil surveys provided the information needed for the irrigation classification.

The general soil map will also be useful in community or broad-area planning. For example, from the general soil map of Mora County, information can be obtained about the location of large tracts of land with soils suitable for the development of irrigation. It also shows those areas with soils best suited to range, recreation, wildlife, or other uses, as well as the general location of soils that will present problems in the construction of roads or building foundations.

The general soil map 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 Mora County. Detailed soil surveys were available only for the irrigated lands and small areas of rangeland where special studies had been conducted. The general soil map of this county, therefore, was prepared largely on the basis of a field reconnaissance 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,

[1]Soil Scientist and Professor, respectively, Department of Agronomy, New Mexico State University.

[2]Soil Scientist, Soil Conservation Service, U.S. Department of Agriculture, Raton, New Mexico.

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), which is small-scale and shows only general soil areas or soil associations, 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 a distinctive proportional pattern of soils. Since each kind of soil normally occurs in comparatively small rather than large areas, the associations on the general soil map of Mora County are generally made up of two or more kinds of soil. In addition, land types and a number of minor soils are commonly components of the associations 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.

When the soil data were assembled, 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 Council[3] and 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 has 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. Class 1 has few or no limitations for use as cropland under irrigation. It is land that is productive and well adapted to irrigation. High yields of most climatically adapted crops can be obtained on these lands 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 Mora 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 were 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 major soil properties and qualities and related land factors that affected the placement of land in the various irrigation land classes were: soil texture (including gravel and stone content), effective soil depth, available water-holding capacity, salinity, permeability, erosion, surface smoothness, slope, internal soil drainage, and surface drainage. For example, the Apache, Travessilla, Penrose, and Midway soils are classed as non-irrigable because of the limited effective soil depth and very low moisture-retention capacity. The Hayspur-like soils, although deep and of high water-holding capacity, were placed in irrigation land class 4 primarily because of high water tables and inadequate drainage. In the western 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 Colmor-Swastika-Berthoud association which is dominated by land in class 2 because of favorable soil properties and related land factors. Slope and unevenness of the land surface were the principal reasons for placing these soils in class 2 instead of class 1.

Description of Area

Location and Topography

Mora County, comprising an area of about 1,944 square miles, or 1,244,200 acres, is located within

[3]Proceedings Water Resource Council, Irrigation Land Classification Seminar, Salt Lake City, Utah, July 1967.

Table 1. Land classification specifications for Pacific Southwest Basin irrigation land classes[1]

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
Moisture Retention (AWHC-48")[3]	> 6.0"	4.5" 6.0"	3.0" 4.5"	2.5" 3.0"	criteria for
Effective Depth (inches)	> 40[4]	30- 40	20 - 30	10 - 20	arability
Salinity ($EC_e \times 10^3$ - equil.)	< 4	4 - 8	8 - 12	12 - 16	
Sodic Conditions[5]					
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	

[1]Specifications 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.

[2]Finer 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.

[3]In 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.

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

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

[6]Severity 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.

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

[8]Special 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.

[9]Air 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

the northeastern part of New Mexico. It is bounded on the south by San Miguel County and on the north by Colfax County, which has as its north boundary the New Mexico-Colorado state line. The crest of the Sangre de Cristo mountain range and the Canadian River form the western and eastern boundaries of this county, respectively. It lies within both the Southern Rocky Mountain and Great Plains physiographic provinces.[4]

The western part of the county, in the Southern Rocky Mountain physiographic province, is a high mountainous and wooded area with elevations ranging from about 7,500 feet in the foothill areas to 12,500 feet on Pecos Baldy Peak. Although topography varies considerably, most of this is characterized by a rough and broken topography, including steep and very steep mountain slopes and canyons. The Pecos River originates in the extreme western part of the county and flows south into San Miguel County. Much of this mountainous area, however, is drained by the Mora River and its tributaries. These streams, which drain to the east and southeast, cut across a series of hogbacks, or steep ridges in the mountain foothills area. Intermingled with these hogbacks and moderately steep to steep foothill areas are gently to strongly sloping valley bottoms wherein most of the irrigated land in Mora County occurs.

To the east of the mountainous area, the county is dominated by an extensive plateau, or plains area, that slopes generally to the east. This is the western extension of the Great Plains physiographic province, and the native vegetation is predominantly grass. The topography generally ranges from nearly level to gently sloping to gently rolling with an occasional deep canyon. A few moderately steep to steep small isolated mountain peaks and ranges of hills are also scattered throughout this plains area. The largest and most prominent of these are the Turkey Mountains, located southwest of Wagon Mound. Moderately steep to steep basalt cones and escarpments also interrupt the plains in the north-central and central parts of the county covered by lava flows.

The extreme eastern part of the county immediately adjacent to the Canadian River is characterized by steep rough broken topography and dissected breaks. The Canadian River, which occurs in a relatively deep canyon, is separated from the upland plains area to the west by a series of steep to very steep sandstone escarpments and canyon walls.

Except for isolated and small mountain peaks and hills, the altitude in the plains area ranges from about 5,000 in the southeast corner near the Canadian River to 7,500 feet near the base of the mountains in the western part of the county. Elevations of 6,000 to 7,000 feet, however, are dominant over much of the plains and plateau area in the eastern part of the county.

[4] Fenneman, N.M. 1931. Physiography of the Western United States, McGraw-Hill Book Co., New York.

Climate[5]

The climate of Mora County is semi-arid except in the mountains. Temperatures are generally cool because of the high elevations. There are large ranges of annual and diurnal temperature, plentiful sunshine, and low relative humidities, characteristic of continental climates. The county's main source of moisture is the general clockwise air circulation from over the Gulf of Mexico, around the Bermuda high-pressure area. The greatest rainfall comes in July and August, when nearly one-half of the annual average occurs. Nearly 80 percent of the annual

[5] This section was prepared by Frank E. Houghton, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Climatologist for New Mexico.

Table 2. Monthly temperatures and precipitation, Levy, Mora County, New Mexico, for period ending 1960*

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperatures (F°)												
Average daily maximum	46	49	55	65	71	82	84	82	78	69	57	47
Average daily minimum	13	16	21	30	39	47	52	51	43	32	20	13
Mean daily	30	33	38	47	55	65	68	67	60	58	38	30
Extreme maximum	72	81	80	84	90	98	99	97	95	87	79	72
Extreme minimum	-29	-27	-25	2	12	30	36	38	15	3	-14	-26
Precipitation												
Average (inches)	.52	.56	.82	1.22	2.19	1.87	3.06	3.17	1.68	1.29	.70	.43
Average days 0.10 inch or more (no.)	2	1	2	2	4	4	7	6	3	3	1	1
Average snowfall (inches)	6.8	6.5	6.5	2.2	0.9	0	0	0	0.4	1.2	5.1	5.3

*Number of years of record: temperatures, 40; average precipitation, 50; average days, 20; and average snowfall, 48

average precipitation occurs in May through October. In winter, the main source of moisture is the Pacific Ocean, and storms moving toward the east in the general air circulation leave much of their moisture on the mountains to the west. Only small amounts, averaging less than one-half inch per winter month, fall in the plains area of Mora County.

The annual patterns of temperature and precipitation for Levy are shown in table 2, and these are generally representative of central and eastern Mora County. Average annual precipitation generally increases with elevation, and ranges from near 15 inches in the Great Plains area of the southeast to 16 to 20 inches in central portions, and to over 25 inches in the Sangre de Cristo Mountains. An average of 36 days a year receive 0.10 inch or more of precipitation, with 12 of them receiving 0.50 inch or more.

There is a large variation in precipitation from year to year and month to month, as shown by annual totals at Optimo of 33.47 inches in 1941 and 4.49 inches in 1956, and by August totals at Gascon of 12.72 inches in 1961 and only 0.34 inch in 1962.

Average annual snowfall ranges from two to three feet in the east and central portions and from five to six feet and greater in the mountains. Occasionally, snowfall in the valley exceeds 10 inches in 24 hours, but usually there is little accumulation on the ground. At Gascon, over 100 inches of snow fell in 1967-68 season, with 42 inches in March 1968.

The average annual temperature ranges from 53 degrees in the southeast to 43 degrees and lower in the mountains. Average temperatures generally decrease three or four degrees for each 1,000 feet increase in elevation. Approximately half the days in the year have freezing temperatures, and an average of from 12 to 30 days reach 90 degrees. Temperatures of 100 degrees are rare, and several days in a year may have sub-zero temperatures. The highest temperature recorded in the county was 101 degrees at Valmora, July 24, 1963, and the lowest, -35 degrees at Valmora, January 13, 1963.

The freeze-free period is nearly 140 days long in most of the county, from mid-May to early October, but high mountain areas have a freeze-free period of more nearly 90 days, June through August. Table 3 shows selected climatological data for various county localities for comparison.

A monthly average of about 70 percent of possible sunshine occurs throughout the year, or an annual average of almost 3,100 hours. Average annual wind speed of about 12 miles per hour may be expected, and during the spring windy season an average of about 15 miles per hour. Winds from the southwest predominate, but direction may vary locally because of topography. Because of the cool temperatures, relative humidity is moderately high, with early morning humidities estimated at almost 75 percent, and afternoon humidities at about 35 percent. Average annual relative humidity is about 55 percent.

Hail may accompany some of the more severe summer thunderstorms but seldom causes much damage. Very few tornadoes occur; however, the most destructive tornado in New Mexico struck at Wagon Mound, May 31, 1930, causing three deaths, 19 injuries, and $150,000 property damage.

Land Use

The village of Mora is reported to be the site of the first permanent settlement in this county. This

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

Station	Elevation	Temperature			Precipitation		Last 32°F or Lower in Spring	First 32°F or Lower in Fall	Time Between Dates
		Mean maximum	Mean minimum	Yrs. of record	Mean annual	Yrs. of record			
	feet	F°	F°	no.	in.	no.	- - average dates - -		days
Fort Union*	6885	64	32	23	18.01	56	May 17	Oct. 5	141
Gascon*	8250	62	27	16	22.88	16	June 10	Sept. 8	90
Levy	6252	65	31	40	17.51	50	May 15	Oct. 1	139
Ocate (1 mi. N)*	7665	62	30	12	16.59	16	May 26	Sept. 22	119
Valmora	6300	66	33	38	16.39	42	May 12	Oct. 1	142
Chacon	8400				19.84	51			
Ojo Rico Ranch*	6000				15.27	15			
Optimo*	6400				15.54	18			

*Period of record: Fort Union, through 1918; Gascon, through 1969; Ocate, through 1970; Ojo Rico Ranch, through 1956; and Optimo, through 1959

settlement was made by a number of Mexican families after the Mora Land Grant was given to them in 1835 by Governor Albino Perez. These settlers established small farms and built an irrigation system to supply water for their fields. The farmers sold their produce to the Army, which established Fort Union nearby in 1851, and to freighters on the Santa Fe Trail that traversed the county near Watrous.

Irrigated agriculture, therefore, is an old industry in Mora County. The acreage under cultivation, however, has apparently fluctuated considerably since the establishment of irrigated farming. Some of the early data available on agriculture in this county may be misleading, as there have been some changes in the boundaries of Mora County since its creation in 1860. According to an unpublished soil survey report, in the late 1930s approximately 49,000 acres of land were under cultivation in Mora County, and of this acreage, about 21,000 acres were irrigated and 28,000 acres were dry-farmed.

In 1967, surveys made in conjunction with a conservation needs inventory indicated that approximately 18,000 acres of land were irrigated and 6,414 acres were dry-farmed in Mora County.[6] The high altitude, which results in a short growing season, limits the number of crops that can be grown successfully. Alfalfa and other irrigated hay and pasture crops are the most extensive. These forage crops which are generally fed locally and marketed in the form of livestock are important to the economy of this county. A number of other crops are also grown, but most are of very limited acreage. These include small grains, corn, dry beans, grain and forage sorghums, orchards, and vegetable crops.

A large percentage of the land in Mora County is used for grazing livestock. Ranching, therefore, remains the principal agricultural enterprise, and in 1969 there were approximately 23,000 head of cattle and 12,000 sheep on the farms and ranches in this county.[7]

The use of land for forestry, wildlife, and recreation is also important in this county. Soil associations 9, 12, 13, 14, and 15 (figure 1), in particular, support fair to good stands of timber. All the high mountainous areas of this county as well as adjacent foothills and the steep Rock Land and Stony Land association (No. 10) adjacent to the Canadian River provide good habitat for many species of wildlife. It also offers many opportunities for outdoor recreation including camping, fishing, hunting, and other activities of similar nature.

The use of the land in each soil association is shown in the following list. For a use to be listed, it must apply to at least one 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.

Soil Map Symbol and Soil Association		*Land Use*
1.	Torreon-Thunderbird-Crews	Range
2.	Loma-Carnero-Tricon	Range
3.	Colmor-Swastika-Berthoud	Range
4.	LaBrier-Manzano-Loma	Farming (irrigated and dryland); range
5.	Remunda-Stroupe-Crews	Range
6.	Bernal-Travessilla-Carnero	Range
7.	Apache-Haxtun	Range
8.	Penrose-Renohill-Midway	Range
9.	Bond-Fortwingate	Range; forestry
10.	Rock Land-Stony Land	Range
11.	Rock Land-Encierro-Carnero	Range
12.	Nambe-Cundiyo	Range; forestry
13.	Dargol-Stony Land	Range; forestry
14.	Sinnigam-Barela-Burnac	Range; forestry
15.	Etown-Angostura	Range; forestry
16.	Gaines-Hayspur	Farming (irrigated and dryland); range
17.	Vermejo-Rumunda	Range; irrigated farming

Description of Soils

Seventeen soil associations are shown in figure 1. Each of these includes soils that are geographically associated and comprise recognizable landscapes. They are named for the major soil series and land types that occur within them. In addition to the named soils, they 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. Torreon-Thunderbird-Crews association

Included in this association are nearly level to gently sloping and undulating plains in the north-central part of the county. The soils, which range from shallow to deep, are forming dominantly in materials derived from basalt or other volcanic materials. Although the areas included are charac-

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

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

teristically nearly level to gently sloping with slope gradients of less than five percent, a very limited acreage of strongly sloping to moderately steep basalt rockland areas are included. These more sloping areas usually occur on the sides and terminal points of the lava flows or those parts of the association that slope towards the intermittent drainageways. This is one of the larger associations in the county, as it includes an area of about 173,560 acres, or approximately 14 percent of the county.

It is used for grazing livestock and wildlife and supports a relatively dense cover of native vegetation. The dominant or more common species are blue grama, wolftail, western wheatgrass, sideoats grama, galleta, vine mesquite, three-awns, broom snakeweed, and fringe sage.

Soil Characteristics. Torreon soils, which are deep and dark colored, usually occupy the more level and slightly depressional areas in this association. Slope gradients seldom exceed two percent. These soils have a surface layer of dark grayish-brown noncalcareous silt loam or loam over a thick clayey subsoil. The upper part of the subsoil is a brown to dark brown, blocky, noncalcareous clay loam. The lower part is more compact and consists of a yellowish-brown blocky clay. Below the subsoil at a depth of about 36 inches is a brown calcareous clay loam or sandy clay loam that is easily penetrated by roots. A white or pinkish-white layer of high lime accumulation commonly occurs at a depth of 50 to 60 inches.

The Thunderbird soils in this association occur intermingled with the Torreon soils on nearly level to gently sloping landscapes. They are characterized by dark grayish-brown noncalcarous silt loam or loam surface layers. Their subsoils consist of a brown to dark brown clay loam or clay. A moderate accumulation of lime typically occurs in the soil layer immediately above the underlying basalt bedrock which is usually encountered at depths of 30 to 60 inches. Thin lime coatings also commonly occur in the cracks and on the surface of the basalt bedrock. A few basalt fragments or stones may occur in both the surface layer and subsoil.

Crews-like loam occurs on both nearly level crests and gently sloping sides of upland plains and ridges. These soils have thin grayish-brown to brown calcareous loam surface layers and brown calcareous silt loam or loam subsoils. They are underlain by indurated caliche at depths ranging from 10 to 20 inches. This in turn is usually underlain by basalt bedrock at variable depths but generally within 40 inches of the surface. Angular fragments of caliche range from a few in the surface layer to many in the subsurface layer immediately above the indurated caliche.

Soils of lesser extent in this association include those of the DeMaya, Capulin, and Rudd series. The DeMaya soils, which occur in concave and slightly depressional areas, typically have thick dark-colored surface layers and clayey subsoils. They resemble the Torreon soils, but differ in having thicker dark colored surface horizons. The Capulin soils, like the other soils in this general soil area, are developing in materials derived mainly from basalt or from other volcanic materials. They have dark grayish-brown loam surface layers and grayish-brown to brown clay loam subsoils. A very pale brown or white cobbly loam containing a high content of lime typically occurs within 40 inches of the surface. The Rudd soils, which are shallow, have grayish-brown cobbly loam or loam surface layers. The surface layer grades through a cobbly or gravelly loam containing a high content of lime to the underlying basalt bedrock at depths of 10 to 20 inches. Basalt Rock Land, a miscellaneous land type, also comprises a small acreage in this association. It consists of a complex of shallow stony soils and outcrops of basalt bedrock that occur on the sides and fronts of lava flows.

Irrigation Potential. Approximately 68 percent of the land in this association has been classified as suitable for irrigation. The Torreon soils, which are well suited for use as cropland under irrigation account for most of the land in irrigation land class 2 (38 percent). The Thunderbird soils, although suitable for irrigation, have moderate to severe limitations for such use due primarily to their moderate depth and water-holding capacity. These soils, which are underlain by basalt bedrock at depths of 30 to 60 inches, were placed in irrigation land class 4. The Crews-like soils and Basalt Rock Land are non-irrigable primarily because of the limited soil depth, steep slopes, and cobble and stone content.

2. Loma-Carnero-Tricon association

This association consists of an area of approximately 205,255 acres in the south-central and eastern parts of the county at elevations ranging from about 5,700 to 7,200 feet. Nearly level to gently undulating topography with slopes seldom exceeding five percent prevails on the upland areas and plains included in this general soil area. The soils are dominantly moderately deep and deep and well drained. Those of moderate depth are underlain by sandstone or indurated caliche.

Fig. 3. Typical landscape of Loma-Carnero-Tricon association (No. 2). The deep Loma soils in foreground are well suited to irrigation.

This association supports a good cover of grass with blue grama, galleta, western wheatgrass, mesa dropseed, ring muhly, and three-awns being the more important species. A few woody species, consisting dominantly of juniper, may also occur along the margins of this unit, particularly where it joins areas of Rough Broken and Stony Land.

Soil Characteristics. The deep well drained soils in this association are represented by soils of the Loma series. They typically have a surface layer of brown to grayish-brown noncalcareous silt loam or loam and a moderately thick brown blocky clay or heavy clay loam subsoil. This is underlain at a depth ranging from about 30 to 36 inches by a pale brown to light yellowish-brown light clay loam or sandy clay loam substratum. A moderate zone of lime accumulation in the form of small soft masses and threads commonly occurs at depths of 24 to 50 inches.

The Carnero soils usually occupy the high positions in this association. They are also located in the nearly level to gently sloping landscapes adjacent to drainages. They generally have a thin surface layer of brown to dark brown noncalcareous loam over a subsoil of brown or reddish-brown clay loam that is free of lime in the upper part. This grades through a light brown sandy clay loam or loam in which threads and small soft masses of lime are common to underlying sandstone bedrock that occurs at a depth ranging from 20 to 40 inches.

Tricon soils, the other major component of this association, have brown to grayish-brown noncalcareous silt loam or loam surface layers. Their subsoil is a brown heavy clay loam or clay that is noncalcareous in the upper part. This is underlain by hard or strongly cemented caliche at depths ranging from 20 to 50 inches. These soils commonly occur on broad nearly level to gently sloping and undulating upland plains.

Other soils of importance in this association include those of Bernal, Travessilla, and Crews series. The Bernal and Travessilla soils, which are shallow, are underlain by sandstone bedrock within 20 inches of the surface. The Travessilla soils consist of stony fine sandy loams or stony loams. The Bernal soils differ in that they contain few coarse sandstone fragments and have finer textured or sandy clay loam subsoils. The Crews soils, which have dark colored loamy surface layers and heavy clay loam subsoils, are underlain by indurated caliche at depths of less than 20 inches. Also included in this unit are small acreages of Rock Land, Rough Broken and Stony Land, and soils forming in materials of shale and limestone origin. The soils forming in these materials range from shallow to moderately deep, and are medium to moderately fine-textured.

Irrigation Potential. Although the capability of the land in this association for irrigation varies widely, there is considerable potential for expansion of irrigation in the areas comprising this unit. Approximately 40 percent of this land has been placed in irrigation land class 1; 10 percent is in class 2; 15 percent is in class 3; 20 percent is in class 4 and the remaining 15 percent is non-irrigable (class 6). The Loma soils, which are well suited to irrigation, account for most of the land in classes 1 and 2. Slope and unevenness of the land surface were the principal factors contributing to the placement of a small acreage of the Loma soils in class 2. The Tricon and Carnero soils, which are in irrigation land classes 3 and 4, respectively, have moderate to severe limitations for irrigation. This is due primarily to their moderate depth and water-holding capacity, and the underlying indurated caliche or sandstone bedrock which will tend to restrict drainage or free movement of water through these soils.

3. Colmor-Swastika-Berthoud association

This association, comprising an area of approximately 142,775 acres, is mainly in the northeastern part of the county. It includes extensive areas of deep, well drained soils occurring on gently sloping and undulating landscapes at elevations ranging from about 5,800 to 7,000 feet. The elevation above 6,500 occurs in the small area of this associa-

tion located in the south-central part of the county. The soils are usually medium to fine-textured and are forming in alluvial sediments derived principally from sedimentary rocks.

Fig. 4. General view of the gently sloping and undulating landscape that is characteristic of the Colmor-Swastika-Berthoud association (No. 3)

They support a good cover of grass with blue grama, galleta, western wheatgrass, buffalograss, ring muhly, sand dropseed, and three-awns representing the more important species. Some alkali sacaton and vine mesquite also usually occur in the swales and on the flood plains adjacent to intermittent drainages.

Soil Characteristics. The Colmor soils are mainly on side slopes of ridges and fans, or on gently sloping and undulating areas. Slope gradients seldom exceed five percent. These soils have a thick surface layer of grayish-brown to brown calcareous loam or silt loam over a brown to light yellowish-brown subangular blocky silty clay loam subsoil. This is underlain by a pale brown to light browish-gray silt loam or light silty clay loam substratum. It is strongly calcareous and commonly contains a few small soft masses and filaments of lime.

Swastika soils commonly occupy the smoother and nearly level to gently sloping landscapes in this association. They typically have a thin surface layer of dark brown to grayish-brown noncalcareous silt loam over a thick brown, blocky clay or heavy silty clay loam subsoil. A moderate to strong lime zone typically occurs in the clay loam or silty clay loam substratum at depths of 30 to 40 inches.

Berthoud soils, the other major component of this association, usually occupy the upper parts of the side slopes and the more strongly sloping areas within this general soil area. These soils normally have a surface layer about 10 inches thick of brown or grayish-brown calcareous loam. This is underlain by light yellowish-brown loam or light clay loam to a depth of 60 inches or more. A few specks and streaks of segregated lime are common below a depth of 15 to 20 inches.

Other soils of importance in this association include those of the Vermejo, Litle, Las Lucas, and Penrose series. The Vermejo soils occur on broad, gently sloping alluvial fans and in wide nearly level to gently sloping drainageways. Both of these land forms are often dissected by shallow drainage channels. The Vermejo soils have yellowish-brown, calcareous silty clay subsurface layers. The Litle and Las Lucas soils, which occupy gently to strongly sloping and undulating upland ridges, are developing in parent materials weathered residually from the underlying shale. The depth to shale varies from 20 to 40 inches. The Las Lucas soils have pale brown to brown, calcareous surface layers and brown clay loam subsoils. The Litle soils differ principally in being finer textured. They have a thin surface layer of grayish-brown calcareous clay loam over a clay or silty clay subsoil. The Penrose soils, which are shallow, are underlain by thinly bedded limestone and shale at depths of 8 to 20 inches.

Irrigation Potential. There is a high potential for development of irrigated land in this association. It occurs generally as a large continuous tract of land dominated by soils well suited for use as cropland under irrigation. Approximately 75 percent of the land in this general soil area is in class 2; 8 percent in class 3; 7 percent in class 4, and only 10 percent is non-irrigable, or in class 6. The Colmor, Swastika, and Berthoud soils account for most of land placed in irrigation land class 2. Slope and unevenness of the land surface were the principal factors contributing to the placement of these soils in land class 2. With leveling, installation of irrigation systems, and application of good farming practices, the land in this unit is of sufficient productive capacity to support sustained irrigation.

4. LaBrier-Manzano-Loma association

Included in this association are nearly level to gently sloping valley bottoms and adjacent valley side slopes. The individual units or areas comprising

this association are widely distributed throughout the central part of the county, and are commonly contiguous to the larger drainages. The soils, which are generally deep and dark colored, are forming in medium to fine-textured alluvial sediments of mixed origin. Approximately 63,770 acres, or slightly less than five percent of the county is included in this association.

The major part of the 10,400 acres of irrigated cropland in Mora County is in this association. Alfalfa and other irrigated hay and pasture crops are the most extensively grown crops. The non-irrigated lands provide grazing for livestock and wildlife. In general, the soils are productive, but forage production varies considerably depending on the amount of additional moisture by runoff from adjacent areas. Vegetation is dominated by mid and short grasses including blue grama, western wheatgrass, vine mesquite, galleta, mat muhly, alkali sacaton, switchgrass, and some fringe sage, chamiza, and winterfat. A few cottonwood trees and shrubs also commonly occur on the flood plains contiguous to the larger streams.

Soil Characteristics. The LaBrier soils occur on the nearly level to very gently sloping terraces and side slopes in this general soil area. They have a surface layer, about nine inches thick, of dark grayish-brown noncalcareous granular silt loam, over a thick grayish-brown blocky clay subsoil. This is underlain to a depth of five feet or more by a clay loam or light clay that usually contains a few specks and threads of lime.

Manzano soils, which are also extensive in this association, commonly occur on nearly level to very gently sloping swales and flood plains that are contiguous to the drainages. The surface layer, which ranges from 6 to 12 inches in thickness, is a brown to dark brown noncalcareous loam. The subsoil is a brown to dark brown clay loam that has a moderate blocky structure. This is underlain by a substratum of brown sandy clay loam or light clay loam.

The Loma soils, which occupy the higher and more sloping portions in this association, have a moderately thick surface layer of brown noncalcareous silt loam or loam. The subsoil is a brown to dark brown heavy clay loam or clay about 20 inches thick. This is underlain by brown to reddish-brown clay loam or sandy clay loam that commonly contains threads and small soft masses of calcium carbonate.

Other soils of lesser extent in this general soil area include those of the Tricon, Bernal, and Carnero series. These soils occur near the outer edges of this unit on the more strongly sloping landscapes. The Tricon and Carnero soils, which are moderately deep, are underlain by indurated caliche and sandstone, respectively, at depths of 20 to 40 inches. Bernal soils are shallow and are underlain by sandstone at depths of 6 to 20 inches. The Torreon, Crews, and Vermejo soils also occur to a limited extent in this association. The Torreon soils are deep and occupy nearly level to gently sloping landscapes. They are characterized by their dark grayish-brown granular silt loam surface layers and angular blocky clay loam to clay subsoils. The Crews soils, which also occur on upland landscapes, are loamy soils underlain by indurated caliche at depths of 10 to 20 inches. The Vermejo soils are deep and have gray, granular silty clay loam surface layers and gray silty clay subsurface layers. They commonly occupy nearly level to very gently sloping swales and valley bottoms. Drainage bottoms, arroyos, and small areas of miscellaneous land types comprise the remaining parts of this general soil area.

Irrigation Potential. This association, like the Colmor-Swastika-Berthoud association, has a high potential for expansion of irrigated land. Approximately 75 percent of the land in this general soil area is in class 2, and 13 percent is in class 3. A part of the land classified as suitable for irrigation, however, is already irrigated or is being used for roads or built up areas. The LaBrier, Manzano, and Loma soils, which account for practically all the land placed in irrigation land class 2, are well suited for irrigation. The LaBrier and Manzano soils, because of their low position, are susceptible to occasional overflow and development of inadequate drainage or high water tables. Slopes and unevenness of the land surface were the principal factors contributing to placement of the Loma soils in class 2. The wide distribution of these irrigable lands in relatively narrow and meandering valley bottoms, will undoubtedly tend to preclude the use of some of these lands for irrigation, because of the high development costs.

5. Remunda-Stroupe-Crews association

This association, consisting of about 13,525 acres, occurs in the west-central part of the county in the vicinity of Rainsville. It is mainly on gently to strongly sloping and rolling uplands. Although slopes are dominantly less than 10 percent, some short slopes with gradients ranging from 10 to about 25 percent are included. These occur mainly on the sides of ridges occupied by the Crews-like soils. The soils, which are extremely variable, are

forming dominantly in parent materials weathered from sedimentary formations including shales and interbedded sandstone, siltstone, and shale. In addition to the sedimentary materials, a veneer of gravelly alluvium covers the surface in many parts of this unit and has also contributed to the parent materials in which these soils are developing. The soils in this association vary extremely in susceptibility to erosion and in soil depth, which ranges from shallow to deep. The gravel and stones on the surface of many of these soils tend to stabilize the soil surface and reduce the erosion hazard. The non-stony soils are susceptible to erosion if the vegetative cover is depleted.

This association is used for grazing livestock and wildlife and has a fair to good cover of vegetation. The more common species of native vegetation include blue grama, muhly species, three-awns, fringe sage, and snakeweed.

Soil Characteristics. The Remunda soils occur generally on gently to strongly sloping valley side slopes and alluvial fans. They typically have a surface layer of brown to dark brown noncalcareous loam over a thick reddish-brown sandy clay or clay subsoil. This is underlain at a depth ranging from 36 to 50 inches by a reddish-brown or light brown sandy clay loam that usually contains a few small soft masses and threads of lime.

Stroupe-like soils occur on strongly sloping and undulating terraces and valley slopes slightly above the landscapes occupied by the Remunda soils. These soils, in contrast to the associated Remunda soils, are gravelly and cobbly. They have a surface layer of reddish-brown noncalcareous cobbly sandy clay loam over a thick gravelly and cobbly clay subsoil. This in turn is underlain by a reddish-brown massive clay substratum that typically contains a few pebbles and cobbles. It is common for small soft masses and threads of lime to occur throughout the substream. A moderate zone of lime accumulation may occur at a depth of 55 to 60 inches.

Crews-like soils, the least extensive of the major soils in the association, are on the sloping and undulating crests and moderately steep side slopes of ridges and terraces. These soils normally consist of less than 24 inches of brown to dark brown cobbly loam over partially cemented layers of caliche. The caliche layer is underlain by interbedded shales, siltstone, sandy shale, and limestone.

Also included in this soil association are soils of the Loma, Carnero, and Bernal series. The Loma soils are deep and have brown noncalcareous silt loam or loam surface layers and blocky heavy clay loam or clay subsoils. The Carnero soils which have brown noncalcareous surface layers and reddish-brown clay subsoils are underlain by sandstone bedrock at depths of 20 to 40 inches. Gullied Land, Rock Land, and arroyo bottoms also comprise small acreages in this association.

Irrigation Potential. This association contains a relatively high percentage of land classified as irrigable (78 percent), but it offers only limited opportunity for expansion of irrigation because the entire acreage is small and class 4 and 6 land is intermingled with the land of high capability for irrigation. The Stroupe-like soils, because of high stone and gravel content, slope, and limited water-holding capacity, were included in irrigation land class 4. The Remunda soils, which are in irrigation land class 2, are well suited for use as cropland under irrigation. They will merit consideration for irrigation when they occur in tracts large enough to be economically developed for use.

6. Bernal-Travessilla-Carnero association

Included in this association are gently sloping to moderately steep and rolling uplands underlain dominantly by sandstone bedrock along the eastern and southern margins of the county. The soils in this unit, for the most part, are developing residually in materials weathered from sandstone, with shale and other sedimentary rocks contributing minor amounts. Locally, and particularly where the soils are of moderate depth or deeper, there have been additions of eolian and alluvial sediments. This association comprises an area of approximately 126,655 acres, or 10 percent of the county.

Soils of this association are in native range and produce fair to good forage yields under good management. They support a relatively complex mixture of mid and short grasses, including such species as blue grama, sideoats grama, sand dropseed, galleta, and little bluestem. Thin stands of juniper and pinyon trees are also common on the Travessilla and Bernal soils and near the outer fringes of this unit where it adjoins the Rock Land and Stony Land association.

Soil Characteristics. Bernal soils, which occupy gently sloping and rolling landscapes, have a thin surface layer of brown noncalcareous fine sandy loam or loam over a reddish-brown sandy clay loam subsoil. This is typically underlain by sandstone bedrock at about 12 inches, but may range in depth from about 10 to 20 inches.

Travessilla soils are shallow, gently sloping to

Fig. 5. Typical landscape of Bernal-Travessilla-Carnero association (No. 6). Travessilla stony loam in foreground.

moderately steep soils developing on sandstone mesas and breaks. They have a surface layer of brown stony fine sandy loam or stony loam. This is underlain by sandstone bedrock at depths ranging from 4 to 15 inches. In addition to the angular sandstone fragments which are common on the surface and throughout the soil, sandstone bedrock outcrops occasionally.

Carnero soils, the other principal member of this association, occupy gently to strongly sloping and undulating uplands. They generally have a thin surface layer of brown to dark brown noncalcareous loam over a subsoil of brown or reddish-brown clay loam that is free of lime in the upper part. This grades through a light brown sandy clay loam or loam in which threads and small masses of lime are common to sandstone bedrock at depths ranging from 20 to 40 inches.

In addition to the three principal soils, minor soils include those of the Berthoud, Loma, Remunda, and Crews series. The Berthoud soils are deep and medium-textured, the Loma and Remunda soils are deep soils with medium-textured surface layers and fine-textured subsoils, and the Crews soils are shallow. The cobbly loam Crews soils are underlain by partially cemented layers of caliche, siltstone, and shale within a depth of two feet. Also included are small acreages of rough broken and stony soils.

Irrigation Potential. The potential for development of irrigated land in this association is very limited. Travessilla and Bernal soils, the two major and most extensive soils in this association, are unsuitable for use as cropland under irrigation. Carnero soils, although classified as irrigable, have moderate to severe limitations due primarily to their moderate depth over sandstone bedrock. Approximately 76 percent of the land in this association is non-irrigable, or is in class 6; 15 percent is in class 4; and the remaining 5 percent is about equally divided between classes 2 and 3.

7. Apache-Haxtun association

Included in this association are soils forming in materials of volcanic or basic igneous origin on old lava flows and basalt mesas in the central part of the county. It consists of a number of widely separated areas comprising approximately 70,640 acres. A characteristic feature of this unit is the stony and rocky nature of many of the soils. These soils are dark colored and are generally shallow to moderately deep. The land surface on the tops of the mesas and lava flows is dominantly gently to strongly sloping, but it ranges from nearly level to moderately steep. The sides of basalt-capped mesas and volcanic hills, or plugs, as well as the fronts of lava flows are steep to very steep.

This association is used for grazing livestock and wildlife, but stoniness, rockiness, and strong slopes tend to limit accessibility to domestic stock. It is dominated by grass vegetation, including blue grama, galleta, sand dropseed, western wheatgrass, sideoats grama, little bluestem, big bluestem, and three-awns. The more common shrubs and woody species are snakeweed, chamiza, oak brush, and scattered pinyon and juniper trees.

Soil Characteristics. The Apache soils, which are an important component of this association, are typically shallow and stony. The dark grayish-brown granular surface layers contain variable amounts of angular and semi-rounded fragments of basalt. They are commonly calcareous and of a loam or clay loam texture. Basalt fragments usually increase slightly with depth, and unweathered basalt is usually encountered within a depth of 20 inches. The lower part of the profile just above the basalt typically contains a moderate to high amount of segregated lime. Nearly all areas of these soils include exposures of basalt and in some places the basalt fragments comprise a large percentage of the soil mass.

The nearly level to gently sloping Haxtun-like

Fig. 6. Apache-Haxtun association (No. 7) in background Torreon-Thunderbird association (No. 1) in foreground.

soils occur on the smoother and less sloping parts of this general soil area in association with the Apache soils. The Haxtun-like soils have a surface layer of very dark grayish-brown noncalcareous stony loam over brown to dark brown sub-angular blocky stony clay loam subsoil. This grades through a white to pinkish-white stony loam lime layer, about six inches thick, to the underlying basalt bedrock which occurs at a depth ranging from 20 to 40 inches.

Basalt Rock Land, a miscellaneous land type, occurs on steep and very steep escarpments, lava flow fronts and isolated basalt hills or outcrops. It consists of a complex of shallow rocky soils and outcrops of basalt bedrock. Much of the surface between the outcrops of basalt is covered with boulders and stones. It is not very susceptible to erosion because most of the surface is protected by rock.

Also in this association are soils of the Cabezon, Thunderbird, and Torreon series. The Cabezon soils, which are shallow and dark colored, occur on gently sloping to moderately steep ridge crests and hills. These soils have a surface layer of dark grayish-brown noncalcareous stony loam and a brown or reddish-brown cobbly clay subsoil. Basalt bedrock occurs at a depth ranging from about 10 to 20 inches. The Torreon and Thunderbird soils occupy the small areas of smooth and nearly level to very gently sloping landscapes in this association. These soils have dark grayish-brown noncalcareous silt loam or loam surface layers over clayey subsoils. They differ principally in that the Torreon soils have a greater thickness of effective soil material. The depth of the Thunderbird soils is limited by basalt bedrock which occurs at depths ranging from 30 to 60 inches.

Irrigation Potential. This association, which is dominated by stony and shallow soils, offers little opportunity for development of irrigated land. Basalt bedrock and Apache and Cabezon stony loams, which account for nearly 60 percent of the land in this general soil area, are not suitable for use as cropland under irrigation. The only soils in this unit with a high capability for irrigation (class 2) are those of the Torreon series. The very limited acreage of these soils occurs as small areas interspersed with large tracts of class 4 and 6 land, restricting their potential for irrigation. The Haxtun-like soils, although classified as suitable for irrigation (class 4), have a relatively low capability for such use. The moderate depth to basalt bedrock, moderate water-holding capacity, and stone content were principal reasons for placing them in irrigation land class 4.

8. Penrose-Renohill-Midway association

This association is dominated by gently to strongly sloping and undulating uplands in the northeastern part of the county at elevations ranging from about 5,800 to 7,000 feet. Although slopes are generally less than 10 percent, some of the Penrose soils occupy moderately steep to hilly landscapes with slopes up to 25 percent. In addition, the included limestone and shale Rock Land that consists of a complex of shallow soils and outcrops of shale and limestone is usually steep. It consists of an area of 47,395 acres, or four percent of the county.

The soils, which are mainly shallow to moderately deep, calcareous, and erodible are forming dominantly in materials weathered from gray and olive colored shales or interbedded limestone and shale. Small areas of deep fine-textured soils also occur in the nearly level to gently sloping valley bottoms. The soils of this association are used for grazing of livestock and wildlife and support a fair to good cover of native vegetation. It consists mainly of blue grama, galleta, buffalograss, sideoats grama, mat muhly, three-awns, and some western wheat-

grass, vine mesquite, chamiza, and snakeweed. Sparse and scattered stands of pinyon and juniper trees also occur on the breaks or more sloping areas within this association.

Soil Characteristics. Penrose soils, the most extensive in the association, are forming on gently to strongly sloping and rolling interbedded limestone and shale ridges and knolls. They have a thin surface layer of grayish-brown calcareous loam or channery loam. This grades through a light brownish-gray loam or clay loam that usually contains some partly weathered shale and limestone fragments, to the underlying interbedded limestone and shale which occurs at a depth of less than 20 inches.

Renohill soils, which are also extensive in this association, occupy gently to strongly sloping and undulating uplands. They are forming in fine-textured material weathered residually from the underlying shale which occurs at a depth ranging from 20 to 40 inches. These soils usually have a thin surface layer of dark gray calcareous loam and a subsoil of grayish-brown clay loam or silty clay loam. Small soft masses of lime and gypsum crystals are common in the subsurface layers immediately above the underlying shale.

The Midway soils, like those of the Penrose series, are shallow. They have a dark brown to dark grayish-brown calcareous loam surface layer over a subangular blocky clay loam subsoil. This is underlain by shale at a depth ranging from 10 to 20 inches. Small soft masses and threads of lime are common in the subsurface layer immediately above the underlying shale.

Also included in this association are soils of the Vermejo, Colmor, Swastika, and Litle series. Limestone and shale Rock Land, which includes the steep breaks dominated by a complex of shallow soils and outcrops of limestone and shale, also occurs to a limited extent. The deep Vermejo soils occur mainly in the nearly level to gently sloping valley bottoms. They have yellowish-brown, calcareous silty clay subsurface layers. The Colmor and Swastika soils occupy gently sloping and undulating uplands. These deep, medium to fine-textured soils are like those described in the Colmor-Swastika-Berthoud association (No. 3). The Litle soils, which occur on gently sloping uplands, are underlain by shale at a depth ranging from about 20 to 40 inches. They have a thin surface layer of grayish-brown calcareous clay loam over a clay or silty clay subsoil.

Irrigation Potential. The potential for development of irrigated land in this association is very limited. The Colmor and Swastika soils, which comprise only a small acreage in this association, are well suited to irrigation. However, these soils commonly occur as small tracts intermingled with class 4 land or non-arable land, and their potential for irrigation development is thus limited. The Renohill soils, which are included in irrigation land class 4, have severe limitations for sustained use under irrigation. These moderately fine-textured and slowly permeable soils are underlain by shale at moderate depths. The underlying shale will tend to restrict the free movement of water through these soils, and localized salinity and drainage problems can therefore be expected to develop. The Penrose and Midway soils, due to their shallow depth over shale or interbedded limestone and shale, are not suitable for irrigation. Approximately 69 percent of the land in this association has been placed in land class 6 as non-irrigable.

9. Bond-Fortwingate association

Included in this association is the Turkey Mountain area in the central part of the county. It comprises an area of about 28,100 acres, or slightly more than two percent of the county. Steep mountainous landscapes with slope gradients of 15 to 60 percent or more are characteristic of this general soil area. Although slope gradients are generally within this range, small areas with slopes of less than 15 percent do occur on the tops of a few of the upland ridges and in some of the narrow valley bottoms. Elevations in the area range from about 7,000 feet to approximately 8,400 feet on the mountain peaks. The soils, which are dominantly shallow to moderately deep, are forming in materials weathered from sedimentary rocks consisting principally of sandstone. In addition to stones, which are common in many of the soils, sandstone bedrock outcrops occasionally on the steeper slopes.

This association is suitable for varied uses, including recreation, livestock and wildlife grazing, a watershed area, and production of commerical timber.

It supports good stands of native vegetation consisting of pinyon, juniper, ponderosa pine, oak brush, and mountain mahogany with an understory of cool-season grasses. The more common grasses are Arizona fescue, mountain muhly, mountain brome, little bluestem, big bluestem, blue grama, western wheatgrass, and sideoats grama.

Soil Characteristics. Bond soils usually occur on moderately steep to steep mountain slopes with

gradients ranging from about 25 to 45 percent. A thin layer of decomposing forest litter usually covers the surface. These soils typically have a thin surface layer of noncalcareous stony loam or stony fine sandy loam. The subsoil is a reddish-brown, noncalcareous sandy clay loam. This layer is underlain by sandstone bedrock. The depth to bedrock is commonly 10 to 18 inches, but may range from 6 to 20 inches. A few sandstone fragments are common in the soil layers immediately above the sandstone bedrock.

Fortwingate soils in this association occupy strongly sloping to rolling crests and steep side slopes of ridges. They have a surface layer of brown granular stony loam over a reddish-brown blocky sandy clay or clay subsoil. Sandstone bedrock commonly occurs at an average depth of about 30 inches and ranges from 20 to 40 inches. These soils are generally noncalcareous, but occasionally the layer immediately above the sandstone is weakly calcareous. A thin layer of decomposing forest litter commonly covers the surface in the more heavily wooded areas.

Other soils of importance in this association include those of the Loma, Carnero, and Bernal series. These soils occur on gently to strongly sloping and rolling grassland and pinyon and juniper areas at the lower elevations in this general soil area. The Loma soils, which are deep, have brown noncalcareous loam or silt loam surface layers and blocky heavy clay loam or clay subsoils. The Carnero soils, which have brown to dark brown noncalcareous surface layers and reddish-brown clay loam subsoils, are underlain by sandstone bedrock at a depth of 20 to 40 inches. Bernal soils resemble those of the Carnero series, but differ in that they are underlain by sandstone bedrock within 20 inches of the surface.

Rock Land and Stony Alluvial Land, which are the more common land types, also comprise small acreages in this association. Rock Land consists of a complex of shallow stony soils and outcrops of sandstone bedrock. The outcrops of bedrock commonly occur as vertical or nearly vertical exposures or ledges. Stony Alluvial Land occupies positions at the base of escarpments and breaks or in narrow valley bottoms. It is dominated by alluvial and colluvial sediments containing numerous coarse fragments, principally of sandstone origin. The surface is typically covered by numerous boulders, stones, and pebbles.

Irrigation Potential. This association, dominated by steep and mountainous topography, offers little or no opportunity for development of irrigated land because of steep slopes and many shallow, stony, and rocky soils. The only soils that have characteristics and properties suitable for irrigation are those of the Loma series, and these occur in this association as small and irregularly shaped tracts.

10. Rock Land-Stony Land association

This association includes the steep and precipitous canyon walls and breaks adjacent to the Canadian River, as well as a few other steep escarpments between upland areas and the lower lying valleys and plains. A characteristic feature of this unit, therefore, is the rough broken topography and relatively narrow valley floors and upland summits separated by steep canyon walls and escarpments. It includes an area of about 26,770 acres, or two percent of the county.

The land in this general soil area is used principally for grazing. The very steep slopes together with the rock outcrops and stony soils tend to restrict livestock grazing, but the association provides a good habitat for many species of wildlife. Although the density of vegetation is restricted by rock outcrops and related features, this unit supports a wide variety of grasses and shrubs. Blue grama, galleta, sideoats grama, little bluestem, big bluestem, switchgrass, sand dropseed and threeawns are the principal grasses. The more common shrubs and woody species include pinyon, juniper, big sage, bitterbrush, serviceberry, snakeweed, rabbitbrush, oak brush, and an occasional scrub pine.

Soil Characteristics. Rock Land, which is dominant in this association, consists of a complex of shallow soils and outcrops of sandstone and other types of sedimentary rocks. A few localized areas of basalt outcrops are also included. The outcrops of bedrock commonly occur as vertical or nearly vertical exposures or ledges. A thin mantle of rocky or stony soil generally occurs between the ledges or outcrops of bedrock. Although shallow soils and rock outcrops are dominant, small isolated pockets of moderately deep to deep stony soils do occur on the escarpments where benches or areas with a lesser slope gradient have formed.

Stony Land usually occurs on steep slopes below the Rock Land in this association. It differs essentially from the Rock Land in having numerous loose rocks, boulders, and stones on the surface instead of outcrops of bedrock.

Exposures of shales and clays with interbedded sandstone also occur to a very limited extent in the southeastern part of the county. The ridges above

these steep and very steep escarpments are often covered with water-worn gravel. Deep alluvial soils contiguous to the narrow drainageways and shallow soils of the Bernal and Travessilla series comprise most of the remaining acreage in this association. In the areas dominated by igneous materials small areas of soils shallow over basalt, however, are included.

Irrigation Potential. Because shallow soils, rock outcrops, and steep rough broken landscapes dominate this association, there is little, if any, opportunity to develop irrigated land. Only a few hundred acres, consisting of deep alluvial soils in valley bottoms, have been classified as suitable for irrigation. The small size and isolated location of these irrigated lands will undoubtedly preclude their use for irrigation.

11. Rock Land-Encierro-Carnero association

This association, which includes an area of approximately 41,460 acres, occurs in the western part of the county in the general vicinity of Lucero Village. It includes the hilly to steep mountain foothill and intermediate mountain areas occurring at elevations ranging from about 7,000 to 8,200 feet. The narrow valley floors and upland summits are commonly separated by steep escarpments, canyon walls, and steep side slopes. The ridge tops, which are generally narrow, are strongly sloping to moderately steep and rolling. The narrow valley floors below the escarpments and steep side slopes are gently to strongly sloping.

A wide variety of rocks are contributing to the parent materials in which the soils of this general soil are developing. Sandstone, shale, quartzite, schist, and gneiss are the more common types. These rock types often outcrop on the steep slopes and occur in a complex pattern with stony and shallow soils.

These steep mountainous and rocky lands support a wide variety of grasses, shrubs, and trees. The density of the vegetation in many parts of this association, however, is restricted because of the steep slopes, thin soils, and rock outcrops. The escarpments, rock ledges, and steep slopes also tend to limit accessibility for livestock grazing. The association, however, provides a good habitat for many species of wildlife. The vegetation consists of pinyon, juniper, and ponderosa pine, oak brush, and various other shrubs with an understory of grasses. The dominant grasses are blue grama, Arizona fescue, sideoats grama, sleepygrass, western wheatgrass, and three-awns.

Soil Characteristics. Approximately 50 percent of this association has been included in a land type identified as Rock Land. It includes those parts of this general soil area that are dominated by numerous outcrops of bedrock and that usually occur on steep to very steep slopes. It consists of a complex of outcrops and shallow soils with variable characteristics. The shallow soils that are intermingled with the rock outcrops, however, are generally cobbly or stony and moderately coarse to moderately fine-textured. Stones and boulders occur on much of the soil surface.

Although the soils included in this complex are usually shallow, small areas of moderately deep or deep soils do occur interspersed with the shallow soils, rock outcrops, and rock ledges.

Encierro soils occur on strongly sloping to moderately steep and rolling ridge crests and side slopes in this general soil area. The surface layer consists of about six inches of reddish-brown stony silty clay loam over a thin reddish-brown silty clay subsoil. This grades through a gravelly or cobbly silty clay loam to the underlying interbedded shale, sandstone, and siltstone within a depth of 20 inches. The coarse fragments which are both angular and rounded, comprise about 15 to 35 percent of the surface layer and the layer immediately above the underlying sandstone and shale. These soils are weakly calcareous to noncalcareous.

The Carnero-like soils occupy the smoother and less sloping areas in this association. Slopes, however, range from about 10 to 25 percent. These deep soils have a surface layer of weak red noncalcareous loam. Their subsoil is a dark reddish-brown blocky and noncalcareous sandy clay loam. This is underlain at a depth of 20 to 30 inches by a reddish-brown sandy clay loam or loam that usually contains a few small soft masses and threads of lime.

Also in this association are Alluvial Land, Stony Land, and soils of the Mirabal and Travessilla series. The Travessilla soils, which are underlain by sandstone bedrock within 20 inches of the surface occur on strongly sloping to hilly mountain foothill areas at the lower elevations. They usually have light reddish-brown to brown stony surface layers. The Mirabal soils are also shallow, but differ in that they are forming over gneiss and schist. They have a surface layer of dark grayish-brown to grayish-brown noncalcareous stony loam. This grades through a very stony loam to the underlying bedrock occurring at a depth of 15 to 20 inches.

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 topography preclude the use of this land for irrigation. The only soils with properties suitable for irrigation are the small areas of deep alluvial soils. The small size, location, and isolated nature of these lands will generally preclude their use for irrigation.

12. Nambe-Cundiyo association

Included in this association is a high mountain area consisting of about 29,600 acres in the southwestern part of the county. Although the altitude ranges from slightly less than 9,000 feet to 12,500 feet on Pecos Baldy, it dominantly is between 9,000 and 11,500 feet. The land form pattern is long, steep slopes crowned by relatively broad ridgetops. Slope gradients of 5 to 75 percent or more are characteristic of this general soil area. The average slope is approximately 45 percent on the side slopes and 5 percent on the broad ridgetops. The soils, which are forming in materials weathered mostly from granite and quartzite, range from neutral to strongly acid in reaction. They are generally permeable, and most of the water moves underground to emerge as springs or seeps.

Water and timber for scenic values are probably the most important resource products of this soil area. Typically it supports a thick stand of Engelmann spruce, but at lower elevations white fir, Douglas fir, and aspen are prevalent. Kobresia, timberline bluegrass, shrubby cinquefoil, and carex species occur on the alpine areas. Although the slopes are steep, erosion is not now a problem in this soil area because of good plant cover, surface rock, and a high rate of vegetation recovery.

Soil Characteristics. Nambe soils, which commonly occur at elevations above 9,000 feet, are forming in glacial till. They occupy steep to very steep mountain slopes with gradients ranging from 20 to about 70 percent. The surface layers are light brown to brown very strongly acid gravelly or stony loams. A two- to three-inch layer of fresh or partly decomposed organic material commonly occurs on the surface. The subsoil is a reddish-brown strongly acid gravelly or stony sandy loam, about 15 to 20 inches thick. This is underlain by a substratum of brown, strongly acid, gravelly or stony sandy loam. The content of coarse fragments in the subsoil and substratum, which vary in size from gravel to stones, ranges from about 30 to 60 percent.

Cundiyo soils, which usually occur between elevations of 9,000 and 10,000 feet, are forming in alluvium from acid igneous rocks. These soils have a thick surface layer of light brownish-gray gravelly sandy loam. It is about 20 inches thick, slightly acid in reaction, with a surface cover of about two inches of fresh or partially decomposed organic material. The subsoil commonly extends to a depth of 50 to 60 inches and consists of a light brownish-gray and brown, slightly acid, gravelly or stony sandy loam. The content of coarse fragments in the subsoil ranges from about 30 to 90 percent. These coarse fragments are commonly coated with clay.

Also in this association are soils of Bobtail, Penitente, Lunch, and Tampico series, along with some Rock Land, Rock Slides, and drainageways. The Bobtail soils, which are forming in valley filling sediments of acid igneous origin are often associated with outcrops of bedrock. They have light brownish-gray, strongly acid, loam surface layers over pale brown stony subsoils and substrata. The Penitente soils occur on high mountain tops at elevations of about 12,000 feet or more. These soils are characterized by their very dark gray to dark brown cobbly loam surface layers and very cobbly and very stony subsoils and substrata with a content of coarse fragments ranging from 50 to 80 percent. They are strongly to very strongly acid. The Lunch soils, which are poorly drained, occupy basins and low areas in high mountain valleys. These soils have a 3- to 10-inch surface layer of peat over a silt loam mineral soil that is dark grayish-brown in the upper parts and of variable color in the lower layers. Many large prominent mottles indicating restricted drainage are common in these lower subsurface layers. Tampico soils, which occur in alluvial valley bottoms, are forming in alluvium derived principally from granite, gneiss, and schist. These deep well-drained soils have very dark gray loam surface layers over grayish-brown loam subsurface layers that often contain a few gravel.

Irrigation Potential. This association is dominated by stony and rocky soils on steep and mountainous topography, hence there is little or no opportunity for development of irrigated land. All the land in this association has been included in class 6.

13. Dargol-Stony Land association

This association, comprising an area of about 64,025 acres, occurs in the west-central part of the county. It is dominated by mountainous topography that ranges from gently to strongly sloping and rolling on the broad ridge tops to steep and

very steep on the side slopes and escarpments that extend down from the ridge tops into the deep canyons. Elevations generally range between 8,000 and 10,500 feet. It consists mainly of moderately deep soils developing in parent materials weathered residually from interbedded shale and sandstone and intermingled land types consisting of steep Stony Land and Rock Land.

Except for the Rock Land component, soils of this association are productive and support good stands of native vegetation that is dominated by ponderosa pine, Douglas fir, and white fir. Some Engelmann spruce also grows on the north-facing slopes and at the higher elevations. The understory, which consists of a wide variety of shrubs and grasses, includes shrub oak, kinnikinnick, Arizona fescue, Thurbers fescue, Junegrass, pine dropseed, little bluestem, big bluestem, and bluegrass. In addition to its value as a watershed area, it is used for timber production, recreation, and wildlife and livestock grazing. It also provides a good habitat for many species of wildlife including deer, elk, bear, and turkey.

Soil Characteristics. Dargol soils, the most extensive in the association, have a surface layer of very pale brown stony loam. This is about six inches thick, neutral to slightly acid in reaction, and commonly has surface cover of about two inches of decaying forest litter. The subsoil consists of a yellowish-brown to strong brown angular blocky stony clay. This is underlain at a depth of 20 to 40 inches by interbedded sandstone and shale. The underlying shale and sandstone is commonly weathered in the upper part.

Stony Land usually occurs on steep slopes below outcrops of sandstone bedrock. It consists of deposits of stony colluvial and alluvial sediments of variable thickness. It differs essentially from the Rock Land component of this unit in having numerous loose rocks, boulders, and stones on the surface instead of outcrops of bedrock.

Rock Land, the other miscellaneous land type of importance in this association, consists mainly of a complex of shallow soils and outcrops of sandstone and shale. It occurs generally on the steep to very steep side slopes with the outcrops occurring as vertical or nearly vertical exposures and ledges. The interspersed soils are usually shallow and moderately coarse to moderately fine-textured. Numerous stones and boulders are common on the surface of the included soils. Although these soils are dominantly shallow, small areas and pockets of moderately deep to deep soils do occur interspersed with the shallow soils, rock outcrops, and rock ledges.

The remaining parts of this association consist of small acreages of Alluvial Land, drainageways, and a number of unclassified soils. The unclassified soils are generally shallow, cobbly, and stony.

Irrigation Potential. Because of rough broken and mountainous topography and steep slopes, there is no potential for development of irrigation in this association. The soils of this general soil area are best used for forestry, range, recreation, and watershed. All the land in this unit is included in land class 6, which is non-irrigable.

14. Sinnigam-Barela-Burnac association

This association, comprising an area of approximately 67,615 acres, lies in the northwest part of the county at elevations ranging from about 7,500 to 10,500 feet. The topography is varied and ranges from gently to strongly sloping and undulating on the mesa and ridgetops to steep on the mountain side slopes. The sides of basalt-capped mesas and escarpment fronts of lava flows are generally very steep. The soils are developing dominantly in materials of volcanic or basic igneous origin, principally basalt. They range in depth from shallow to deep and are often stony and rocky. Outcrops of basalt bedrock are common on the escarpments and mesa fronts. Small ridges also occur on many of the mesa tops where bedrock outcrops or the shallow soils are extremely stony.

Vegetation varies widely on the soils of this association. The Barela soils usually occur in the open, park-like areas dominated by a grass cover, including such grass species as bluegrass, Arizona fescue, blue grama, buffalograss, western wheatgrass, and mountain muhly. A few ponderosa pines and clumps of oak brush and other shrubs are often scattered or interspersed throughout these grassland areas. In the remaining parts of this association, and particularly at the higher elevations, the overstory vegetation consists generally of white fir, Douglas fir, limber pine, ponderosa pine, and some Engelmann spruce, aspen, oak brush, and mountain mahogany. The more common grasses associated with this mixed conifer forest type are Junegrass, Arizona fescue, Thurbers fescue, bluegrass, mountain brome, and mountain muhly.

Soil Characteristics. Sinnigam-like soils, which are shallow, stony and dark colored, occur generally on the gently sloping and undulating to moderately steep mesa tops and ridge crests. Surface stones and a few outcrops of basalt bedrock are common. These soils have a surface layer of dark grayish-brown noncalcareous stony silt loam or

stony loam. Their subsoil is a brown very stony clay loam. This is underlain by basalt bedrock at a depth ranging from 10 to 20 inches.

Barela soils, which are moderately deep to deep and dark colored, usually occupy the nearly level to strongly sloping open grassland on basalt-capped mesas. These soils have a surface layer of dark gray or dark grayish-brown noncalcareous silt loam over a thick clayey subsoil. The upper part of the subsoil is a brown to dark brown noncalcareous silty clay or stony silty clay. The lower part, which is coarser textured and contains more coarse fragments, consists of a stony silty clay loam. Basalt bedrock occurs at an average depth of about 40 inches, but may range from 30 to as much as 60 inches below the surface. The boundary between the soil and basalt bedrock is indistinct as the very stony substratum grades into the fractured basalt bedrock.

The Burnac soils are forming in parent materials of volcanic origin, including basalt, on moderately steep to steep wooded mountainside slopes. The surface layers are reddish-gray to reddish-brown neutral to slightly acid stony loams and cobbly loams. One to two inches of fresh or partly decomposed forest litter commonly occur on the surface. The subsoil is a thick reddish-brown to red cobbly or stony clay that typically contains from 20 to 30 percent coarse fragments. This is underlain at an average depth of about 40 inches by clay-coated gravel, cobble, and stones.

Basalt Rock Land, a miscellaneous land type, occurs on steep and very steep escarpments, lava flow fronts, and isolated basalt hills or outcrops. It consists of a complex of shallow rocky soils and exposures or outcrops of basalt bedrock. Much of the surface between the outcrops of basalt is covered with boulders and stones, which protect it from erosion.

The remaining parts of this association include soils of the Raton series, deep clayey soils, and other miscellaneous land types. The Raton soils are shallow stony loam soils underlain by basalt bedrock within a depth of 20 inches. These deep clayey soils occur in nearly level to very gently slight depressional areas. The surface layers and subsurface layers are clay or silty clay and crack widely and deeply upon drying. Also included on the nearly level to gently sloping mesa tops are many small intermittent lakes and depressional areas. They usually contain water for short periods following heavy rains during late summer or early fall seasons.

Irrigation Potential. The potential for development of irrigated land in this association is extremely limited. The Barela soils, which occur on high mesas at elevations near 8,000 feet, account for most of the land classified as suitable for irrigation. These soils, although suitable for irrigation, have moderate to severe limitations for such use primarily because of their moderate depth over basalt bedrock and occasional outcrops of basalt and stones. They are in irrigation land class 4. The shallow and stony Sinnigam-like soils, the steep and stony Burnac soils, and Basalt Rock Land are non-irrigable, in land class 6.

15. Etown-Angostura association

This association includes about 116,615 acres of mountainous land in the western part of the county. The altitude ranges from about 8,000 to 12,000 feet but is most commonly between 8,500 and 11,500 feet. It is characterized by mountainous topography that ranges from gently to strongly sloping on the ridgetops to steep and very steep on the side slopes that extend down from the broad ridgetops into the deep canyons. The soils are developing in parent materials weathered from sedimentary rocks including sandstone, shale, limestone, and some conglomerate. They typically have gravelly or stony medium and moderately coarse-textured surface layers that are neutral to slightly acid in reaction. A forest litter of two or more inches commonly covers nearly all of the soil surface under the dense spruce stands at the higher elevations.

This association is used dominantly for timber production, recreation, grazing wildlife, and to a much lesser extent for grazing livestock. It is also an important watershed area, and numerous springs and seeps in the area give rise to many perennial streams. Good infiltration, permeability, and adequate soil depth make possible considerable water storage from gentle rains and spring snowmelt

In general, this association supports a good cover of native vegetation that is dominated by tree species. The more common are Engelmann spruce, Douglas fir, white fir, limber pine, subalpine fir, bristlecone pine, common juniper, and aspen. The understory includes kinnikinnick, whortleberry, rose, Oregon-grape pusstoes, and yarrow. There are also included small grassland areas scattered throughout this general soil area. Vegetation is dominantly Thurbers and Arizona fescues with interspersed cinquefoil, bluegrass, Junegrass, and forbs. Although the erodibility and erosion hazard are moderate to high, active erosion in this soil area is confined mainly to small shaley areas and small gullies on some of the trails and roads. The major-

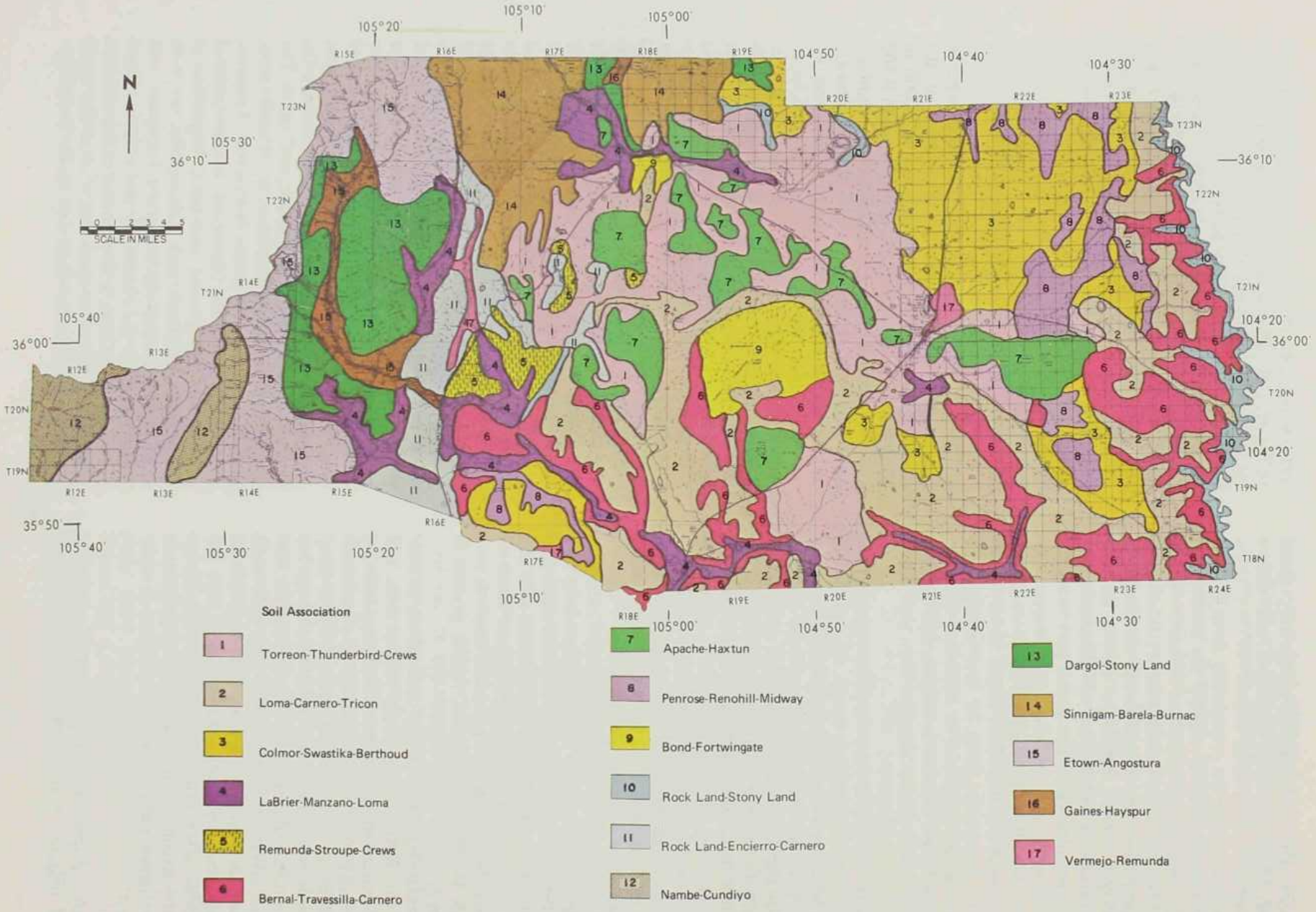
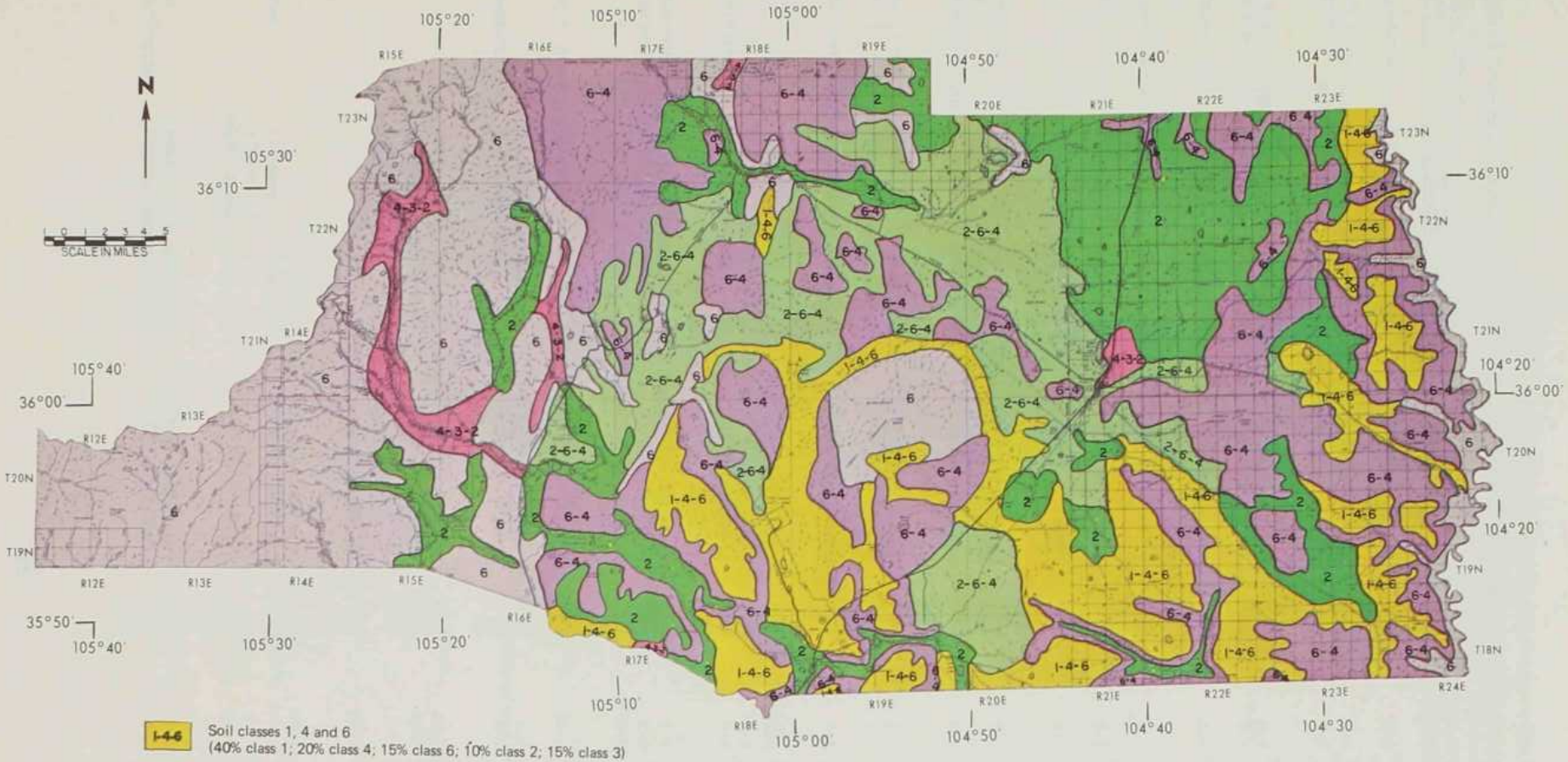


Figure 1. General soil map of Mora County, New Mexico



1-4-6 Soil classes 1, 4 and 6
(40% class 1; 20% class 4; 15% class 6; 10% class 2; 15% class 3)

2 Soil class 2
(75% class 2; 10% class 3; 9% class 6; 6% class 4)

2-6-4 Soil classes 2, 6 and 4
(38% class 2; 32% class 6; 26% class 4; 4% class 3)

4-3-2 Soil classes 4, 3 and 2
(38% class 4; 28% class 3; 18% class 2; 16% class 6)

6-4 Soil classes 6 and 4
(71% class 6; 24% class 4; 3% class 3; 2% class 2)

6 Soil class 6
(99% class 6; 1% class 2)

Figure 2. Classification of land for irrigation in Mora County, New Mexico

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

Soil Map Symbol and Soil Association	Dominant Slope Range (percent)	Approximate Percent of Association	Pedologic Classification		Texture[1]
			Subgroup	Family	
1 Torreon-Thunderbird-Crews					
Torreon silt loam	0-2	35	Aridic Argiustoll	Fine, montmorillonitic, mesic	sil;loam
Thunderbird silt loam	0-2	25	Typic Argiustoll	Fine, montmorillonitic, mesic	sil;loam
Crews-like loam	2-5	25	Petrocalcic Paleustoll	Clayey, mixed, mesic, shallow	Loam
Other soils and land types		15			
2 Loma-Carnero-Tricon					
Loma silt loam	0-3	50	Aridic Argiustoll	Fine, montmorillonitic, mesic	sil;loam
Carnero loam	1-5	20	Aridic Argiustoll	Fine-loamy, mixed, mesic	Loam
Tricon silt loam	3-5	15	Petrocalcic Paleustoll	Fine, mixed, mesic	sil;loam
Other soils and land types		15			
3 Colmor-Swastika-Berthoud					
Colmor loam	1-3	30	Aridic Haplustoll	Fine-silty, mixed, mesic	Loam;sil
Swastika silt loam	1-3	30	Aridic Argiustoll	Fine, mixed, mesic	sil
Berthoud loam	3-5	20	Typic Ustochrept	Fine-loamy, mixed, mesic	Loam
Other soils and land types		20			
4 LaBrier-Manzano-Loma					
LaBrier silt loam	0-2	30	Torrertic Argiustoll	Fine, mixed, mesic	sil;l
Manzano loam	0-3	25	Cumulic Haplustoll	Fine-loamy, mixed, mesic	Loam;cl
Loma silt loam	3-5	20	Aridic Argiustoll	Fine, montmorillonitic, mesic	sil;loam
Other soils and land types		25			
5 Remunda-Stroupe-Crews					
Remunda loam	3-5	40	Aridic Argiustoll	Fine, mixed, mesic	Loam
Stroupe-like cobbly sandy clay loam	5-9	30	Aridic Argiustoll	Clayey-skeletal, mixed, mesic	cosc l
Crews-like cobbly loam	5-9	15	Petrocalcic Paleustoll	Clayey, mixed, mesic, shallow	col
Other soils and land types		15			
6 Bernal-Travessilla-Carnero					
Bernal fine sandy loam	0-20	40	Aridic Lithic Argiustoll	Loamy, mixed, mesic	fsl;loam
Travessilla stony loam	5-25	30	Lithic Ustic Torriorthent	Loamy, mixed (calcareous), mesic	stfsl;stl
Carnero loam	0-9	15	Aridic Argiustoll	Fine-loamy, mixed, mesic	Loam
Other soils and land types		15			
7 Apache-Haxtun					
Apache stony loam	3-9	40	Aridic Lithic Haplustoll	Loamy, mixed, mesic	stl;stcl
Haxtun-like stony loam	0-3	35	Pachic Argiustoll	Fine-loamy, mixed, mesic	stl;stcl
Basalt rockland	15-65+	15	(A miscellaneous land type)		
Other soils and land types		10			
8 Penrose-Renohill-Midway					
Penrose loam	1-10	38	Lithic Ustic Torriorthent	Loamy, mixed (calcareous), mesic	Loam;chl
Renohill loam	1-9	25	Ustollic Haplargid	Fine, montmorillonitic, mesic	Loam
Midway loam	5-9	25	Ustic Torriorthent	Clayey, mixed, non-acid, mesic, shallow	Loam
Other soils and land types		12			
9 Bond-Fortwingate					
Bond stony loam	25-45	45	Lithic Ustollic Haplargid	Loamy, mixed, mesic	stl;stfsl
Fortwingate stony loam	10-25	20	Typic Eutroboralf	Fine, montmorillonitic	stl;stfsl
Other soils and land types		35			
10 Rockland-Stony Land					
Rockland and stony land	25-75	90	(Miscellaneous land types)		
Other soils		10			
11 Rockland-Encierro-Carnero					
Rockland	25-75	50	(A miscellaneous land type)		
Encierro stony silty clay loam	25-45	20	Aridic Lithic Argiustoll	Clayey, mixed, mesic	stsicl;stsi
Carnero-like loam	10-25	15	Aridic Argiustoll	Fine-loamy, mixed, mesic	Loam
Other soils and land types		15			
12 Nambe-Cundiyo					
Nambe gravelly and stony loam	20-70	55	Typic Cryochrept	Loamy-skeletal, mixed	gl;stl
Cundiyo gravelly sandy loam	45-80	25	Typic Cryoboralf	Loamy-skeletal, mixed	gsl;stsl
Other soils and land types		20			

Surface Soil Features		Subsoil Features				Soil Depth[4]	AWHC[5]
Color[2]	Reaction	Texture[1]	Color[2]	Permeability[3]	Substratum	(inches)	(inches)
Dark grayish-brown	Non-calc.	Clay;cl	Yellowish-brown	Very slow	Clay loam or scl; limy below 50 inches	60 or more	7 to 8
Dark grayish-brown	Non-calc.	Clay;cl	Brown to dark brown	Slow	Basalt bedrock	30 to 60	5 to 7
Grayish-brown	Calcareous	sil;loam	Brown	Moderate	Indurated caliche and basalt	10 to 20	1 to 3
Brown to grayish-brown	Non-calc.	Clay;cl	Brown	Slow	Loamy alluvium; limy	60 or more	7 to 8
Brown to dark brown	Non-calc.	cl	Brown or reddish-brown	Moderate to slow	Sandstone bedrock	20 to 40	3 to 6
Brown to grayish-brown	Non-calc.	cl;clay	Brown	Very slow	Indurated and weakly cemented caliche	20 to 50	4 to 7
Grayish-brown to brown	Calcareous	sicl;cl	Brown to light yellowish-brown	Slow	Loamy alluvium	60 or more	7 to 8
Dark brown to grayish-brown	Non-calc.	Clay;sicl	Brown	Very slow	Loamy alluvium; limy	60 or more	7 to 8
Brown to grayish-brown	Weakly calc.	Loam;cl	Light yellowish-brown	Moderate	Loamy alluvium	60 or more	7 to 8
Dark grayish-brown	Non-calc.	Clay	Brown	Very slow	Clayey alluvium	60 or more	7 to 8
Brown to dark brown	Non-calc.	cl;scl	Brown to dark brown	Slow	Loamy alluvium	60 or more	7 to 8
Brown to grayish-brown	Non-calc.	Clay;cl	Brown	Slow	Loamy alluvium	60 or more	7 to 8
Brown to dark brown	Non-calc.	sc;clay	Reddish-brown	Very slow	Loamy alluvium	60 or more	7 to 8
Reddish-brown	Non-calc.	gc;coc	Reddish-brown	Very slow	Clayey alluvium and clay shales	60 to 72	4 to 6
Brown to dark brown	Non-calc.	col	Brown	Moderate	Layers of caliche shale and siltstone	10 to 20	1 to 2
Brown	Non-calc.	scl	Reddish-brown	Slow to moderate	Sandstone bedrock	10 to 20	2 to 3
Brown	Weakly calc.	stl	Pale brown to brown	Moderate	Sandstone bedrock	4 to 15	1 to 2
Brown to dark brown	Non-calc.	cl	Brown or reddish-brown	Slow	Sandstone bedrock	20 to 40	3 to 6
Dark grayish-brown	Calcareous	stl;stcl	Brown	Moderate	Basalt bedrock	6 to 20	1 to 3
Very dark grayish-brown	Non-calc	stcl	Brown to dark brown	Slow	Basalt bedrock	20 to 40	3 to 5
Grayish-brown	Calcareous	Loam;chl;cl	Light brownish-gray	Moderate	Interbedded shale and limestone	6 to 20	1 to 3
Dark gray	Calcareous	cl;sicl	Grayish-brown	Slow	Shale and clayey shale	20 to 40	4 to 6
Dark brown	Calcareous	cl	Grayish-brown	Moderate to slow	Shale	10 to 20	2 to 3
Brown	Neutral	scl	Reddish-brown	Moderate	Sandstone bedrock	10 to 20	1 to 3
Brown	Neutral	sc;clay	Reddish-brown	Slow	Sandstone bedrock	20 to 40	3 to 6
Reddish-brown	Non-calc. to weakly calc.	sic;sicl	Reddish-brown	Very slow	Interbedded shale and sandstone	10 to 20	2 to 3
Weak red	Non-calc.	scl	Dark reddish-brown	Moderate	Loam and sandy clay loam	60 or more	7 to 8
Light brown	Acid	gsl;stsl	Reddish-brown	Rapid	Glacial till	60 or more	4 to 5
Light brownish-gray	Slightly acid	gsl;stsl	Brown	Rapid	Gravelly alluvium	60 or more	4 to 5

Table 4. Continued

Soil Map Symbol and Soil Association	Dominant Slope Range (percent)	Approximate Percent of Association	Pedologic Classification: Subgroup	Pedologic Classification: Family	Texture[1]
13 Dargol-Stony Land					
Dargol stony loam	25-45	50	Typic Eutroboralf	Fine, mixed	stl
Stony land and rockland	25-75	35	(A miscellaneous land type)		
Other soils and land types		15			
14 Sinnigam-Barela-Burnac					
Sinnigam-like stony silt loam	3-15	30	Lithic Argiboroll	Clayey-skeletal, mixed	stsil;stl
Barela silt loam	0-10	25	Aridic Argiboroll	Fine, mixed	sil
Burnac stony loam	25-45	25	Mollic Cryoboralf	Clayey-skeletal, mixed	stl;col
Basalt rockland	25-75	10	(A miscellaneous land type)		
Other soils and land types		10			
15 Etown-Angostura					
Etown stony loam	25-75	40	Typic Eutroboralf	Clayey-skeletal, mixed	stl;gl
Angostura gravelly sandy loam	25-75	25	Typic Cryoboralf	Loamy-skeletal, mixed	gsl;stsl
Loberg-like stony loam	20-75	20	Typic Cryoboralf	Clayey-skeletal, mixed	stl;gl
Other soils and land types		15			
16 Gaines-Hayspur					
Gaines silty clay loam	3-9	50	Pachic Argiboroll	Fine, mixed	sicl
Hayspur-like loam	0-3	35	Fluventic Haplaguoll	Fine-loamy, mixed, non-calc., frigid	vfsl;loam
Other soils and land types		15			
17 Vermejo-Remunda					
Vermejo silty clay loam	0-2	35	Ustic Torriorthent	Fine, mixed (calcareous), mesic	sicl
Remunda sandy clay loam	0-1	20	Aridic Argiustoll	Fine, mixed, mesic	scl
Carnero-like loam	5-9	15	Aridic Argiustoll	Fine-loamy, mixed, mesic	Loam
Other soils and land types		30			

[1]Abbreviations used for textural classes:

fsl - fine sandy loam
gsl - gravelly sandy loam
stsl - stony sandy loam
vfsl - very fine sandy loam
stfsl - stony fine sandy loam
gl - gravelly loam
sil - silt loam
stl - stony loam
stsil - stony silt loam
chl - channery loam
col - cobbly loam
cl - clay loam
coscl - cobbly sandy clay loam
scl - sandy clay loam
gscl - gravelly sandy clay loam
stscl - stony sandy clay loam
sicl - silty clay loam
stsicl - stony silty clay loam
stcl - stony clay loam
vstcl - very stony clay loam
cosel - cobbly sandy clay loam
c - clay
sc - sandy clay
gsc - gravelly sandy clay
gc - gravelly clay
sic - silty clay
stc - stony clay
coc - cobbly clay
stsic - stony silty clay

ity of the soils are well protected by a good cover of vegetation.

Soil Characteristics. The Etown soils, which occupy steep mountain slopes, occur at the lower elevations under a mixed conifer forest type in this general soil area. These soils have a thin surface layer of pale brown, neutral to slightly acid, stony or gravelly loam. This grades through a very pale brown slightly acid stony clay loam to the underlying subsoil at a depth of 10 to 18 inches. The subsoil is a thick strong brown neutral stony and gravelly heavy clay loam or sandy clay. The underlying substratum to a depth of 60 inches or more consists of very gravelly and very stony sandy clay loams and clay loams.

Angostura soils, which occupy the higher elevations in this general soil area, are forming under a spruce-fir forest type. These soils are deep and typically have organic layers of decaying forest litter on the surface. They have a surface layer of grayish-brown, neutral to slightly acid gravelly sandy loam over a thick pale brown, neutral very gravelly and stony sandy clay loam subsoil. The substratum is a light olive gray, massive, very gravelly and stony sandy loam.

The Loberg-like soils also occur on steep slopes at the high elevations in association with the Angostura soils. They resemble the Etown soils but differ primarily in that they occur at higher elevations and are much colder. The texture, color, and sequence of soil layers are like those indicated for the Etown soils.

Also in this association are moderately deep soils forming over limestone, shallow soils developing on shale and sandstone, unclassified alluvial soils, miscellaneous land types including Rock Land, Rough Broken and Stony Land, Alluvial Land, and drainage bottoms. The moderately deep soils referred to usually have grayish-brown or dark brown neutral loam and clay loam surface layers over blocky clay or heavy clay loam subsoils. The depth to the limestone bedrock usually averages 30 inches or more but may range from 20 to 48 inches. The shallow soils are developing residually in materials weathered from interbedded shale and sandstone which

Surface Soil Features		Subsoil Features				Soil Depth[4]	AWHC[5]
Color[2]	Reaction	Texture[1]	Color[2]	Permeability[3]	Substratum	(inches)	(inches)
Very pale brown	Slightly acid	stc	Yellowish-brown to strong brown	Very slow	Interbedded shale and sandstone	20 to 40	3 to 5
Dark grayish-brown	Non-calc.	vstcl	Brown	Slow	Basalt bedrock	10 to 20	2 to 3
Dark gray	Neutral	sic;stsic;stsicl	Brown to dark brown	Very slow	Basalt bedrock	30 to 60	5 to 7
Reddish-gray	Neutral to slightly acid	stc;coc	Reddish-brown to red	Very slow	Cobble and stones and basalt bedrock	40 to 60	4 to 6
Pale brown	Neutral to slightly acid	stcl;gc;gsc	Strong brown	Slow to moderate	Gravelly and stony clay loams	60 or more	4 to 5
Grayish-brown	Neutral to slightly acid	stscl;gscl	Pale brown	Moderate	Stony sandy loam	60 or more	4 to 5
Brown	Neutral	stscl;gscl	Pale brown	Moderate	Sandstone and shale	60 or more	2 to 3
Dark grayish-brown	Calcareous	sicl;sic	Dark grayish-brown	Very slow	Loamy alluvium	60 or more	7 to 8
Grayish-brown	Calcareous	sicl	Olive gray	Slow	Loamy alluvium	60 or more	7 to 8
Gray	Calcareous	sic	Gray	Very slow	Clayey alluvium	60 or more	7 to 8
Brown	Calcareous	Clay;sc	Reddish-brown	Very slow	Loamy and clayey alluvium	60 or more	7 to 8
Weak red	Non-calc.	scl	Dark reddish-brown		Loamy alluvium	60 or more	7 to 8

[2]Colors are for dry soil.
[3]Permeability classes and approximate rates per hour:
Very slow - less than 0.20 inches
Slow - 0.20 to 0.63 inches
Moderate - 0.63 to 2.00 inches
Rapid - 2.00 to 6.30 inches
Very rapid - more than 6.30 inches
[4]Depth in inches from surface of effective soil
[5]AWHC - available water-holding capacity (estimated to a depth of 4 feet or for effective soil material if less than 4 feet)

usually occurs within a depth of 20 inches. They have a brown neutral stony loam surface layer over a pale brown stony and gravelly clay loam or sandy clay loam subsoil. The unclassified alluvial soils usually occur in the narrow valley bottoms and are gently to strongly sloping. They are characterized by thick dark-colored loam and clay loam surface layers over subsurface layers ranging from moderately coarse to moderately fine-textured. Rock Land is also an important component of this association. It consists of a complex of shallow soils and outcrops of bedrock, ridges of rock, and rock slides. The soils occurring as small areas or pockets of soil between the outcrops of bedrock are highly variable. They are, however, usually stony and gravelly with varying amounts of cobble, stone and rock on the surface.

Irrigation Potential. The lands in this association are best used for forestry, recreation, range, and watershed. They provide a good habitat for many species of wildlife. 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 that will tend to preclude their use for irrigation.

16. Gaines-Hayspur association

Included in this association are deep dark-colored soils of high mountain valleys. The association is relatively small, consisting of only about 19,420 acres. It includes the valley and bottom lands adjacent to the Mora River in the vicinity of the Mora and Chacon communities. Elevations range from about 7,000 to 8,300 feet and, as a result, growing seasons are short. The soils in the immediate valley bottoms are nearly level to very gently sloping and usually somewhat poorly drained. The well drained soils on the valley side slopes and alluvial fans are gently to strongly sloping and occasionally undulating.

The land in this association is used primarily for the production of irrigated hay and pasture, and as

Fig. 7. Gaines-Hayspur association (No. 16). These soils are located in high mountain valleys and are well suited for production of irrigated hay and pasture crops.

rangeland. A few scattered tracts of land are also dry-farmed even though this is hazardous under the climatic conditions prevailing in this area. The native range areas support a good cover of vegetation, including such species as bluegrass, Junegrass, sleepygrass, blue grama, mountain brome, red fescue, fringe sage, timothy, and clovers. Sedges, yarrow, and iris also occur, particularly in the bottoms where the soils are poorly drained.

Soil Characteristics. Gaines soils occupy the gently to strongly sloping and undulating valley side slopes and alluvial fans. These soils have a moderately thick surface layer of dark grayish-brown calcareous silty clay loam over a dark grayish-brown silty clay subsoil. This is underlain to a depth of 60 inches or more by a silty clay loam and clay loam substatum. Although the Gaines soils are typically calcareous there are included in this unit soils with noncalcareous surface layers.

The other important component of this association is represented by the poorly drained soils of the Hayspur-like series. These soils, which occur in nearly level to gently sloping valley bottoms where moisture accumulates, are characterized by their dark color and high organic-matter content. They have a surface layer of grayish-brown calcareous very fine sandy loam or loam. The immediate surface layer to a depth of three to five inches typically contains a very high content of organic material. These surface layers grade through an olive gray silty clay loam to the underlying substratum consisting of stratified sandy clay loam, clay loam, and silty clay. These subsurface layers are commonly mottled. The depth to the water table varies with the season and is usually less than four feet.

Also included in this association are a number of land types such as Wet Alluvial Land, Stony Alluvial Land and Rock Land. The Wet Alluvial Land is contiguous to the live streams and is usually affected by both permanent and seasonal high-water tables. Although variable in texture and depth, this type is usually moderately coarse to medium-textured and shallow to moderately deep over sand, gravel, and cobble. Stony Alluvial Land occurs on terminal points of fans and adjacent to perennial intermittent streams. It consists of alluvial sediments containing a high content of stones, cobbles, and gravel on the surface as well as throughout the subsurface layers. Rock Land includes the small areas on the outer fringes of this association dominated by outcrops of sandstone and shale. Arroyo and drainage bottoms also comprise small acreages in this general soil area.

Irrigation Potential. Although this association contains a relatively high percentage of land classified as suitable for irrigation, it offers only limited opportunity for irrigation expansion. In addition to the small acreage in the association, there are a number of other factors contributing to this relatively low potential. Approximately 35 percent of the land in this association was placed in irrigation land class 4, because of wetness and an associated flooding hazard. These lands are best used for the production of irrigated hay and pasture crops. Another important factor is the low temperature and short growing season that prevails in these high mountain valleys. Although soil temperature and length of growing season have not been used as criteria in the irrigation land classification, these factors will place severe restrictions on choice of crops that can be grown. In addition to the class 4 land, approximately 25 percent of the land in this association was placed in class 3; 25 percent in class 2; and the remaining 15 percent is non-irrigable, in class 6.

17. Vermejo-Remunda association

This association, the smallest in the county, comprises an area of about 7,020 acres in the west-central part of the county. Included are nearly level to gently sloping valley bottoms and adjacent gently to strongly sloping valley side slopes. The soils of this association, which are dominantly deep, are developing in alluvium derived principally from sedimentary rocks consisting of shale, sand-

stone, and limestone. The soils in the immediate valley bottoms are somewhat poorly drained and the watertable may be encountered at a depth of six or seven feet or less during the growing season. The fine-textured and poorly drained soils are slightly to moderately saline, but, a small acreage in this association contains a high concentration of soluble salts. These soils are susceptible to water erosion, particularly gully erosion and a few small areas are severely eroded.

This association is used dominantly as hayland, pasture, and rangeland. It supports a good cover of vegetation including alkali sacaton, western wheatgrass, blue grama, galleta, inland saltgrass, vine mesquite, and Canada wildrye, switchgrass and mat muhly. The inland saltgrass and alkali sacaton are more common on the poorly drained and saline soils.

Soil Characteristics. Vermejo soils occupy the nearly level to gently sloping valley bottom positions in this association. They are typically slightly to moderately saline, but areas with high concentrations of soluble salts are included. These deep and somewhat poorly drained soils have a surface layer of gray, calcareous, and granular silty clay loam. This is underlain to a depth of 60 inches or more by a very slowly permeable silty clay or clay.

Remunda soils, like the Vermejo soils, are deep and somewhat poorly drained. They differ from the Vermejo soils in that they have darker-colored surface layers, redder subsoils, less soluble salts, and are generally not as erodible. These nearly level to gently sloping soils have a surface layer of brown calcareous sandy clay loam over a blocky sandy clay or clay subsoil. This is underlain by a substratum that ranges in texture from a sandy loam or clay loam to a sandy clay.

Also in this association are soils of the Carnero-like, Colmor, Renohill, Midway, and Manzano series, and a deep unnamed sandy soil. The Carnero-like soils, which occur on the gently to strongly sloping valley side slopes, are deep and well drained. They have weak red noncalareous surface layers and dark reddish-brown subsoils. The deep Colmor soils are also on gently sloping and undulating valley side slopes. These soils have a thick surface layer of grayish-brown to brown calcareous loam or silt loam over a brown to light yellowish-brown silty clay loam subsoil. The Renohill and Midway soils, which are underlain by shale, are moderately deep and shallow, respectively. The Manzano soils occur in nearly level to gently sloping swales on the valley side slopes. These soils have a thick surface of grayish-brown loam or clay loam over a thick subsoil of dark grayish-brown clay loam. The unnamed deep sandy soils occupy low positions contiguous to the drainages in this association. These soils, which are deep and somewhat poorly drained, have a reddish-brown fine sandy loam or loamy fine sand surface layer over stratified moderately coarse-textured to medium-textured subsurface layers. Arroyo and drainage bottoms and a few small areas of Gullied Land comprise the remaining parts of this general soil area.

Irrigation Potential. Approximately 82 percent of the land in this association has been classified as suitable for irrigation. Much of this irrigable land, however, occurs in valley bottoms and low lying positions where it is subject to accumulation of salts and development of unfavorable drainage conditions. These factors, together with the fine-texture, very slow permeability, salt content, and erosion hazard of many of these soils contributed to the placement of much of this association in irrigation land classes 4 and 3. This class 4 and 3 land, although suitable for irrigation, has severe limitations for such use and in general is best used for production of irrigated hay and pasture crops.

Suitability of Soils for Irrigation

In this section the extent, location, and suitability of soils for irrigation, as well as their placement in the various irrigation land classes are discussed. The acreages of irrigable and non-irrigable land in each of the 17 soil associations are shown in table 5. These estimates and percentages of land in each of the five land 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 Mora County is shown on the irrigation land class map (figure 2). This map was based on the soil association may (figure 1) and the acreages of land classes in each of the soil associations (table 5). The land class or classes shown comprise more than 75 percent of the delineated area. No land class was shown that did not comprise at least 15 percent or more 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 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.

Table 5. Estimated acreages and approximate percentages of land in each irrigation land class by association, Mora County, New Mexico*

Soil Map Symbol and Soil Association	Class 1		Class 2		Class 3		Class 4		Classes 1 to 4 Total		Class 6		Grand Total		Principal Limiting Factor(s)
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	
1 Torreon-Thunderbird-Crews															
Torreon silt loam			60,746						60,746				60,746		Permeability
Thunderbird silt loam							43,390		43,390				43,390		Barrier;stones
Crews-like loam											43,390		43,390		Soil depth;AWHC**
Other soils and land types			5,207		8,678				13,885		12,149		26,034		
Total			65,953	38	8,678	5	43,390	25	118,021	68	55,539	32	173,560	14	
2 Loma-Carnero-Tricon															
Loma silt loam	82,100		20,528						102,628				102,628		Slope
Carnero loam							41,050		41,050				41,050		Barrier;AWHC
Tricon silt loam					30,788				30,788				30,788		AWHC;slope;permeability
Other soils and land types											30,789		30,789		
Total	82,100	40	20,528	10	30,788	15	41,050	20	174,466	85	30,789	15	205,255	17	
3 Colmor-Swastika-Berthoud															
Colmor loam			42,836						42,836				42,836		Slope
Swastika silt loam			42,830						42,830				42,830		Slope;permeability
Berthoud loam			21,415		7,140				28,555				28,555		Slope
Other soils and land types					4,283		9,994		14,277		14,277		28,554		
Total			107,081	75	11,423	8	9,994	7	128,498	90	14,277	10	142,775	12	
4 LaBrier-Manzano-Loma															
LaBrier silt loam			19,131						19,131				19,131		Overflow;drainage
Manzano loam			15,943						15,943				15,943		Overflow;drainage
Loma silt loam			12,754						12,754				12,754		Slope
Other soils and land types	638				8,290		1,913		10,841		5,101		15,942		
Total	638	1	47,828	75	8,290	13	1,913	3	58,669	92	5,101	8	63,770	5	
5 Remunda-Stroupe-Crews															
Remunda loam			5,410						5,410				5,410		Drainage;permeability
Stroupe-like cobbly sandy clay loam							4,058		4,058				4,058		AWHC;stones;slope
Crews-like cobbly loam											2,029		2,029		Soil depth;AWHC
Other soils and land types			541				541		1,082		946		2,028		
Total			5,951	44			4,599	34	10,550	78	2,975	22	13,525	1	
6 Bernal-Travessilla-Carnero															
Bernal fine sandy loam											50,662		50,662		Soil depth;AWHC
Travessilla stony loam											37,997		37,997		Soil depth;AWHC
Carnero loam							18,998		18,998				18,998		Barrier;slope
Other soils and land types			5,066		6,333				11,399		7,599		18,998		
Total			5,066	4	6,333	5	18,998	15	30,397	24	96,258	76	126,655	10	
7 Apache-Haxtun															
Apache stony loam											28,256		28,256		Stones;soil depth;AWHC
Haxtun-like stony loam							24,724		24,724				24,724		Barrier;stones
Basalt Rockland											10,596		10,596		Soil and topography
Other soils and land types			2,120				2,118		4,238		2,826		7,064		
Total			2,120	3			26,842	38	28,962	41	41,678	59	70,640	6	
8 Penrose-Renohill-Midway															
Penrose loam											18,009		18,009		Soil depth;AWHC
Renohill loam							11,849		11,849				11,849		Slope;soil depth
Midway loam											11,849		11,849		Soil depth;AWHC
Other soils and land types			948		1,422		474		2,844		2,844		5,688		
Total			948	2	1,422	3	12,323	26	14,693	31	32,702	69	47,395	4	

Soil Map Symbol and Soil Association	Class 1		Class 2		Class 3		Class 4		Classes 1 to 4 Total		Class 6		Grand Total		Principal Limiting Factor(s)
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	
9 Bond-Fortwingate															
Bond stony loam											12,645		12,645		Slope;soil depth
Fortwingate stony loam											5,620		5,620		Barrier;slope
Other soils and land types			1,405						1,405		8,430		9,835		
Total			1,405	5					1,405	5	26,695	95	28,100	2	
10 Rockland-Stony Land															
Rockland and stony land											24,093		24,093		Soil and topography
Other soils			268						268		2,409		2,677		
Total			268	1					268	1	26,502	99	26,770	2	
11 Rockland-Encierro-Carnero															
Rockland											20,730		20,730		Soil and topography
Encierro-like stony silty clay loam											8,292		8,292		Soil depth;AWHC
Carnero-like loam											6,219		6,219		Barrier;slope
Other soils and land types			415						415		5,804		6,219		
Total			415	1					415	1	41,045	99	41,460	3	
12 Nambe-Cundiyo															
Nambe gravelly loam and stony loam											16,280		16,280		Slope
Cundiyo gravelly sandy loam											7,400		7,400		Slope
Other soils and land types											5,920		5,900		
Total											29,600	100	29,600	2	
13 Dargol-Stony Land															
Dargol stony loam											32,012		32,012		Slope
Stony land											22,409		22,409		Soil and topography
Other soils and land types											9,604		9,604		
Total											64,025	100	64,025	5	
14 Sinnigam-Barela-Burnac															
Sinnigam-like stony silt loam											20,284		20,284		Soil depth;AWHC
Barela silt loam							16,904		16,904				16,904		Barrier;stones
Burnac stony loam											16,904		16,904		Slope;stones
Basalt rockland											6,762		6,762		Soil and topography
Other soils and land types					676				676		6,085		6,761		
Total					676	1	16,904	25	17,580	26	50,035	74	67,615	5	
15 Etown-Angostura															
Etown stony loam											46,646		46,646		Slope
Angostura gravelly sandy loam											29,154		29,154		Slope
Loberg-like stony loam											23,323		23,323		Slope
Other soils and land types			1,160		1,170				2,330		15,162		17,492		
Total			1,160	1	1,170	1			2,330	2	114,285	98	116,615	9	
16 Gaines-Hayspur															
Gaines silty clay loam			4,855		4,855				9,710				9,710		Slope;permeability
Hayspur-like loam							6,797		6,797				6,797		Wetness;overflow
Other soils and land types											2,913		2,913		
Total			4,855	25	4,855	25	6,797	35	16,507	85	2,913	15	19,420	2	
17 Vermejo-Remunda															
Vermejo silty clay loam							1,825		1,825		632		2,457		Salinity;drainage
Remunda sandy clay loam					1,404				1,404				1,404		Drainage;permeability
Carnero-like					1,053				1,053				1,053		Slope
Other soils and land types			70		70		1,334		1,474		632		2,106		
Total			70	16	2,527	36	3,159	45	5,756	82	1,264	18	7,020	1	
Grand Total	82,738	7	263,648	21	76,162	6	185,969	15	608,517	49	635,683	51	1,244,200		

*Percent is of association except Grand Total, which is percent of county

**AWHC is abbreviation for readily available water-holding capacity

The irrigation land classes provide a relative rating of the suitability of land for irrigation. Class 1 land has few or no limitations for irrigation. The limitations for use of land under irrigation increase from 1 through 4, with class 4 having severe limitations for such use. Class 6 land is non-irrigable. An analysis of the irrigation land classification data, as shown in table 5 and figure 2 indicates that the potential for expansion of irrigated land in Mora County occurs primarily in the areas included in the following soil associations:

1. Torreon-Thunderbird-Crews association
2. Loma-Carnero-Tricon association
3. Colmor-Swastika-Berthoud association
4. LaBrier-Manzano-Loma association
5. Remunda-Stroupe-Crews association

An area of approximately 490,200 acres in these five associations (figure 1) has been classified as suitable for irrigation. This represents about 80 percent of the 608,520 acres of land classified as irrigable in Mora County. In addition, all class 1 land (about 82,700 acres) and approximately 93 percent, or about 247,300 acres, of the class 2 land occurs within these associations.

Although none of the soils in the Colmor-Swastika-Berthoud association (No. 3) have been placed in irrigation land class 1, this general soil area undoubtedly offers the best possibilities for expansion of irrigated land in Mora County. Approximately 75 percent of this general soil area is in irrigation land class 2; 8 percent in class 3; 7 percent in class 4; and the remaining 10 percent is non-irrigable, in class 6. It is, therefore, dominated by class 2 land, which is well suited for use as irrigated cropland. In addition, the irrigable soils of this unit occur in relatively large tracts with little interspersed non-irrigable land. Slope and unevenness, or undulating nature of the land surface, were the principal features contributing to the placement of the major soils in this association in irrigation land class 2.

The LaBrier-Manzano-Loma association (No. 4), like the Colmor-Swastika-Berthoud association (No. 3) is also dominated by class 2 land, which has a relatively high capability for irrigation. The two associations were grouped together on the irrigation land class map (figure 2), but the LaBrier-Manzano-Loma association is more widely distributed in meandering valley bottoms that are often relatively narrow or consist of small areas. This may tend to place some restrictions on development of these soils for irrigation. Regardless of these limitations, this general soil area is considered to have a good potential for irrigation on the basis of suitability of soils, as 75 percent of this land is in irrigation land class 2; 13 percent in class 3; 3 percent in class 4; 1 percent in class 1; and only 8 percent is non-irrigable.

The Loma-Carnero-Tricon association (No. 2), which often occurs adjacent to the Colmor-Swastika-Berthoud general soil area in the south-central and eastern parts of the county, also offers opportunities for expansion of irrigation. About 40 percent of the land in this association is in class 1; 10 percent in class 2; 15 percent in class 3; 20 percent in class 4; and the remaining 15 percent is non-irrigable. The Loma soils, which account for most of the land placed in irrigation land classes 1 and 2, are well suited to irrigation. The Carnero and Tricon soils, although classified as irrigable, have moderate to severe limitations for such use primarily because of their moderate depth over sandstone bedrock and indurated caliche, respectively. Due to these characteristics, the Carnero soils have been placed in irrigation land class 4 and the Tricon soils in land class 3.

The Torreon-Thunderbird-Crews association, which includes soils developing dominantly in materials derived from basalt or closely related materials of volcanic origin in the north-central part of the county, also contains a relatively high percentage of land classified as suitable for irrigation (68 percent). The potential for irrigation expansion, however, is less favorable than in the previously discussed associations. This is due primarily to shallow soils and rock outcrops that are intermingled with the soils suitable for irrigation. These soil features were responsible for the classification of approximately 32 percent of the land in this unit as non-irrigable or in land class 6. In addition to the class 6 land, about 38 percent of the land in this association is in class 2; 25 percent in class 4; and 5 percent in class 3. The Torreon soils are in irrigation land class 2 and are well suited to irrigation. These soils will, therefore, merit consideration for irrigation when they occur in tracts of sufficient size or can be developed with suitable soils in adjoining associations. The Thunderbird soils, which account for most of the land included in class 4, have moderate to severe limitations for use as cropland under irrigation due primarily to their moderate depth over basalt bedrock.

The Remunda-Stroupe-Crews association (No. 5), like the Torreon-Thunderbird-Crews association, also contains a high percentage of class 4 and 6 land intermingled with the class 2 land, which has high capability for irrigation. Approximately 44 percent of the land in this association is in irrigation land class 2; 34 percent in class 4; and the remaining 22 percent is non-irrigable, or in class 6.

The Remunda soils account for most of the land in class 2 and have a good potential for irrigation where they occur in tracts of sufficient size.

In addition to these five soil associations, the Gaines-Hayspur (No. 16) and Vermejo-Remunda (No. 17) associations also contain a high percentage of land classified as suitable for irrigation. However, in contrast to the five soil associations listed as having a high potential for expansion of irrigation, the opportunity for developing additional irrigated land in these associations is extremely limited.

The amount of land available in these two associations is small, because they include only about 26,400 acres, a part of which is already irrigated. In addition, they are dominated by land that has a relatively low capability for irrigation. About 38 percent of this land has been placed in class 4; 24 percent in class 3; 22 percent in class 2; and the remaining 16 percent is non-irrigable. Wetness and inadequate drainage were the principal factors contributing to the placement of land in classes 3 and 4. These poorly drained soils are best used for the production of irrigated hay and pasture.

In the remaining soil associations, the amount of irrigable land ranges from little or none in soil associations 9, 10, 11, 12, 13, and 15 to slightly more than 40 percent in soil association 7. About 24 percent of the land in soil association 6 was classified as irrigable, 26 percent in soil association 14, and 31 percent in soil association 8. A high percentage of the land classified as irrigable in these associations, however, has a relatively low capability for irrigation. It is dominated by class 4 land that has moderate to severe limitations for such use. The soils so classified are generally underlain at moderate depths by shale, sandstone, or basalt bedrock. The characteristics of the soils and related land features in these soil associations are, therefore, such that there is little or no opportunity for development of irrigated land. The small acreage of soils with a high capability for irrigation commonly occurs as small tracts that are widely distributed and intermingled with large areas of non-irrigable land.

Of the 608,500 acres of land in Mora County classified as suitable for irrigation, about 14 percent is class 1; 43 percent is class 2; 12 percent is class 3; and 31 percent is class 4. Although climate is an important factor in determining what crops can be grown and what the yields will be, it was not used in this irrigation land classification. Both length of frost-free season and soil temperature generally decrease with elevation. The elevation of most of the potentially irrigable lands in Mora County ranges from about 6,000 to 7,500 feet, and the freeze-free season from about 115 to 140 days. A small acreage of land classified as suitable for irrigation on some of the high mesas and in high mountainous valleys, however, occurs at elevations almost 8,000 feet, with a freeze-free season of 100 days or less.

Suitability for Engineering and Related Uses

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 delineate or 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

Engineering groups estimates of selected soil properties of importance in engineering are given in table 6. Information taken from the 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

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

Soil Map Symbol and Soil Association	Depth from Surface	Classification			Coarse Fraction Greater than 3 Inches	Percentage Less Than 3 Inches Passing Sieve-- No. 4 (4.7mm)	No. 10 (2.0mm)	No. 200 (0.074mm)	Range in Permeability	Shrink-Swell Potential
		USDA texture	Unified	AASHO						
	in.				percent				in/hr	
1 Torreon-Thunderbird-Crews										
Torreon	0-10	Silt loam	ML or CL	A-4		100	100	70-90	0.63-2.00	Low
	10-31	Clay	CH	A-7		100	100	75-95	<0.20	High
	31-42	Silty clay loam	CL	A-6		100	100	85-95	0.20-0.63	Moderate
	42-56	Sandy clay loam	SC or CL	A-6		100	100	35-55	0.20-0.63	Moderate
Thunderbird	0-12	Silt loam	ML or CL	A-4		100	100	70-90	0.63-2.00	Low
	12-27	Clay loam	CL	A-6		100	100	70-80	0.20-0.63	Moderate
	27-42	Silty clay loam	CL	A-6 or A-7		95-100	95-100	85-95	0.20-0.63	Moderate to high
	42+	Basalt bedrock								
Crews-like	0-14	Loam or silt loam	ML or CL	A-4				65-90	0.63-2.00	Low
	14+	Indurated caliche--usually underlain by basalt below 20 inches								
2 Loma-Carnero-Tricon										
Loma	0-11	Silt loam	ML	A-4		100	100	65-90	**0.63-2.00**	Low
	11-35	Heavy clay loam	CL	A-6		100	100	70-90	**0.20-0.63**	Moderate
	35-56	Loam or light clay loam	ML or CL	A-4 or A-6		100	100	60-75	**0.63-2.00**	Moderate
Carnero	0-5	Loam	ML	A-4		100	100	60-75	**0.63-2.00**	Low
	5-30	Clay loam	CL	A-6		100	100	70-85	0.20-0.63	Moderate
	30-35	Loam	ML	A-4		95-100	95-100	60-75	0.63-2.00	Low
	35+	Sandstone bedrock								
Tricon	0-7	Silt loam	ML	A-4		100	100	65-90	0.63-2.00	Low
	7-20	Silty clay	CH	A-7		100	100	90-95	<0.20	High
	20-30	Clay loam	ML or CL	A-6		100	100	70-80	0.20-0.63	Moderate
	30+	Indurated caliche								
3 Colmor-Swastika-Berthoud										
Colmor	0-10	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low
	10-34	Silty clay loam	CL	A-6 or A-7		100	100	85-95	0.20-0.63	Moderate to high
	34-54	Clay loam	CL	A-6		100	100	70-80	0.20-0.63	Moderate
Swastika	0-5	Silt loam	ML or CL	A-4		100	100	65-90	0.63-2.00	Low
	5-22	Clay	CH	A-7		100	100	85-95	<0.20	High
	22-34	Silty clay loam	CL	A-6		100	100	85-95	0.20-0.63	Moderate
	34-60	Light clay loam	CL	A-4 or A-6		100	100	35-55	0.20-0.63	Moderate
Berthoud	0-12	Loam	ML	A-4		100	95-100	60-75	0.63-2.00	Low
	12-50	Light clay loam or loam	CL	A-6		100	95-100	60-75	0.63-2.00	Moderate
4 LaBrier-Manzano-Loma										
LaBrier	0-4	Silt loam	ML or CL	A-4		100	100	70-90	0.63-2.00	Low
	4-40	Clay or silty clay loam	CL or CH	A-6 or A-7		100	100	75-95	<0.20	High
	40-60	Clay loam	CL	A-6		100	100	70-80	0.20-0.63	Moderate
Manzano	0-14	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low
	14-55	Clay loam	CL	A-6		100	100	60-80	0.20-0.63	Moderate
Loma	0-10	Silt loam	ML or CL	A-4		100	100	65-90	0.63-2.00	Low
	10-35	Heavy clay loam	CL	A-6		100	100	70-90	0.20-6.30	Moderate
	35-55	Light clay loam	ML or CL	A-4 or A-6		100	100	60-75	0.63-2.00	Moderate
5 Remunda-Stroupe-Crews										
Remunda	0-10	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low
	10-37	Sandy clay or clay	CL or CH	A-7		100	100	60-95	<0.20	High
	37-60	Sandy clay loam	SC or CL	A-6		100	100	35-55	0.20-0.63	Moderate
Stroupe-like	0-9	Cobbly sandy clay loam	GM	A-4	15 to 35	45-60	45-60	30-40	0.63-2.00	Low to moderate
	9-33	Gravelly clay	GC	A-6	35 to 45	75-85	70-85	50-60	<0.20	Moderate to high
	33-60	Clay	CH	A-7	0 to 5	95-100	95-100	75-95	<0.20	Moderate to high
Crews-like	0-10	Cobbly loam	GM	A-2	50 to 65	25-45	25-45	20-30	0.63-2.00	Low
	10+	Caliche over interbedded shale and sandstone								

6 Bernal-Travessilla-Carnero										
Bernal	0-3	Fine sandy loam	ML or SM	A-4		100	100	50-75	0.63-2.00	Low
	3-12	Sandy clay loam	SC or CL	A-6		100	100	35-55	0.20-0.63	Low to moderate
	12+	Sandstone bedrock								
Travessilla	0-7	Stony loam	GM or GC	A-2	15 to 40	85-95	75-85	35-50	0.63-2.00	Low
	7+	Sandstone bedrock								
Carnero	0-5	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low
	5-30	Clay loam	CL	A-6		100	100	70-85	0.20-0.63	Moderate
	30+	Sandstone bedrock								
7 Apache-Haxtun										
Apache	0-15	Stony loam	GM	A-4	15 to 20	75-90	75-85	45-65	0.63-2.00	Low
	15+	Basalt bedrock								
Haxtun-like	0-6	Stony loam	GM	A-4	15 to 20	80-90	80-90	50-65	0.63-2.00	Low
	6-30	Stony clay loam	GC	A-6	15 to 20	80-90	80-90	55-70	0.20-0.63	Moderate
	30+	Basalt bedrock								
8 Penrose-Renohill-Midway										
Penrose	0-10	Loam	ML or CL	A-4	10 to 15	85-95	85-95	50-65	0.63-2.00	Low
	10-16	Clay loam	CL	A-6	5 to 10	95-100	95-100	70-80	0.20-0.63	Moderate
Renohill	0-8	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low
	8-30	Silty clay loam	CL	A-6 or A-7		100	100	75-95	0.20-0.63	Moderate to high
	30+	Shale								
Midway	0-12	Loam to clay loam	ML or CL	A-4 or A-6		100	100	60-80	0.63-2.00	Moderate
	12+	Shale								
9 Bond-Fortwingate										
Bond	0-5	Stony loam	ML or CL	A-4	15 to 20	80-90	80-90	50-65	0.63-2.00	Low
	5-12	Sandy clay loam	SC or CL	A-6		95-100	95-100	35-55	0.63-2.00	Low to moderate
	12+	Sandstone bedrock								
Fortwingate	0-10	Stony loam	GM or ML	A-4	15 to 20	85-90	80-90	50-65	0.63-2.00	Low
	10-30	Clay or sandy clay	CL or CH	A-6 or A-7	0 to 5	95-100	95-100	65-95	0.20-0.63	Moderate to high
	30+	Sandstone								
10 Rockland-Stony Land										
Rockland and Stony Land	(No estimates made)									
11 Rockland-Encierro-Carnero										
Rockland	(No estimates made)									
Encierro	0-6	Stony silty clay loam	GM or GC	A-4 or A-6	15 to 30	67-75	65-75	55-70	0.63-2.00	Low to moderate
	6-14	Silty clay	CH	A-7	0 to 10	95-100	95-100	85-95	< 0.20	High
	14-18	Gravelly silty clay loam	GM or GC	A-4 or A-6	25 to 40	55-65	55-65	50-60	0.63-2.00	Low to moderate
	18+	Interbedded sandstone and shale								
Carnero-like	0-8	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low
	8-45	Sandy clay loam	CL	A-6		100	100	35-55	0.63-2.00	Low to moderate
	45-60	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low
12 Nambe-Cundiyo										
Nambe	0-8	Gravelly loam	ML	A-4	5 to 15	80-90	60-70	40-50	0.63-2.00	Low
	8-60	Gravelly sandy loam	SM	A-2	25 to 35	85-95	65-75	20-30	2.00-6.30	Low
Cundiyo	0-6	Gravelly sandy loam	SM	A-2	0 to 5	85-95	75-85	25-35	2.00-6.30	Low
	6-20	Sandy loam	SM	A-2	20 to 30	95-100	90-100	30-35	2.00-6.30	Low
	20-33	Gravelly sandy loam	SM	A-2	20 to 30	95-100	90-100	30-35	2.00-6.30	Low
	33-60	Gravelly sandy loam	SM	A-2	25 to 35	75-85	60-75	20-30	2.00-6.30	Low
13 Dargol-Stony Land										
Dargol	0-13	Stony loam	ML or GM	A-4	10 to 25	85-95	80-90	50-65	0.63-2.00	Low
	13-38	Stony clay	CH	A-7	10 to 15	95-100	95-100	75-95	< 0.20	High
Stony Land and Rockland	(No estimates made)									

Table 6. Continued

Soil Map Symbol and Soil Association	Depth from Surface	Classification			Coarse Fraction Greater than 3 Inches	Percentage Less Than 3 Inches Passing Sieve-- No. 4 (4.7mm)	No. 10 (2.0mm)	No. 200 (0.074mm)	Range in Permeability	Shrink-swell Potential
	in.	USDA texture	Unified	AASHO	percent				in/hr	
14 Sinnigam-Barela-Burnac										
Sinnigam-like	0-12	Stony silt loam	GM	A-4	25 to 45	55-65	55-65	40-55	0.63-2.00	Low
	12-18	Stony clay loam	GM	A-2	50 to 75	35-45	35-45	25-35	0.20-0.63	Low
	18+	Basalt bedrock								
Barela	0-4	Silt loam	ML	A-4		100	100	70-90	0.63-2.00	Low
	4-9	Silty clay loam	CL	A-6 or A-7		100	100	85-95	0.20-0.63	Moderate
	9-40	Stony silty clay	GC or CH	A-6 or A-7	20 to 30	75-85	75-85	70-80	< 0.20	High
	40+	Basalt bedrock								
Burnac	0-10	Stony loam	GM	A-4	15 to 25	75-85	75-85	35-50	0.63-2.00	Low
	10-15	Stony clay loam	GM	A-6	15 to 25	75-85	75-85	55-65	0.20-0.63	Moderate
	15-40	Stony clay	GC	A-6	25 to 35	65-75	60-75	50-70	< 0.20	High
	40+	Basalt bedrock								
15 Etown-Angostura										
Etown	0-9	Stony loam	GM	A-4	15 to 25	75-85	70-85	35-65	0.63-2.00	Low
	9-18	Stony clay loam	GM or GC	A-4 or A-6	25 to 40	60-70	60-70	45-55	0.20-0.63	Moderate
	18-60	Very stony clay loam	GM	A-4 or A-2	50 to 75	35-45	35-45	25-35	0.63-2.00	Low
Angostura	0-12	Gravelly sandy loam	GM or GC	A-4	15 to 35	65-80	65-80	25-40	0.63-2.00	Low
	12-54	Stony sandy clay loam	GM	A-4	35 to 50	55-65	55-65	20-35	0.63-2.00	Low to moderate
	54-70	Stony sandy loam	GM	A-2	50 to 75	35-45	35-45	10-20	2.00-6.30	Low
Loberg-like	0-10	Stony loam	GM	A-4	15 to 30	75-85	70-85	35-65	0.63-2.00	Low
	10-20	Stony clay loam	GM or GC	A-4 or A-6	25 to 40	60-70	60-70	45-55	0.20-0.63	Moderate
	20-60	Very stony clay loam	GM	A-4 or A-2	40 to 75	35-45	35-45	25-35	0.63-2.00	Low
16 Gaines-Hayspur										
Gaines	0-7	Silty clay loam	CL	A-6 or A-7		100	100	85-95	0.20-0.63	Moderate
	7-31	Silty clay	CH	A-7		100	100	90-95	< 0.20	High
	31-60	Silty clay loam	CL	A-6 or A-7		100	100	70-80	0.20-0.63	Moderate to high
Hayspur-like	3-6	Loam	ML	A-4		100	100	60-75	0.63-2.00	Low
	6-19	Silty clay loam	CL	A-6 or A-7		100	100	75-95	0.20-0.63	Moderate
	19-34	Sandy clay loam	CL	A-6		100	100	35-55	0.63-2.00	Moderate
	34-60	Silty clay	CH	A-7		100	100	90-95	< 0.20	High
17 Vermejo-Remunda										
Vermejo	0-5	Silty clay loam	CL	A-6 or A-7		100	100	85-95	0.20-0.63	Moderate
	5-60	Silty clay	CH	A-7		100	100	90-95	< 0.20	High
Remunda	0-9	Sandy clay loam	CL	A-6		100	100	35-55	0.63-2.00	Low to moderate
	9-29	Sandy clay	CL or CH	A-6 or A-7		100	100	50-65	< 0.20	High
	29-52	Clay	CH	A-7		100	100	75-95	< 0.20	High
	52-60	Sandy clay	CL or CH	A-6 or A-7		100	100	45-60	< 0.20	
Carnero-like	0-8	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low
	8-45	Sandy clay loam	CL	A-6		100	100	35-55	0.63-2.00	Low to moderate
	45-60	Loam	ML or CL	A-4		100	100	60-75	0.63-2.00	Low

mass. It is the standard procedure used by the U.S. Department of Agriculture to classify soils according to texture.

Highway engineers generally classify soil material in according with 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, and 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 percentages of material as given reflects the normal range for the soil series, and most soils within a series will fall within the range indicated.

Permeability as indicated in table 7 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 a 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 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 of bedrock and caliche, the content of stones and rocks, the suitability for embankments, susceptibility to overflow, erodibil-

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[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. 2 V. and appendix

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

Soil Map Symbol and Soil Association	Suitability as a Source of --		Degree of Limitation for	Corrosion Potenti
	Topsoil	Roadfill	Septic Tank Filter Fields	(untreated steel pi
1 Torreon-Thunderbird-Crews				
Torreon silt loam	Good to a depth of 10 to 15 inches	Poor; clayey material	Severe to moderate; moderately permeable below 30 inches	Moderate
Thunderbird silt loam	Good to a depth of 12 inches	Poor; moderate to high shrink-swell	Severe; basalt at 30 to 60 inches	Moderate
Crews-like loam	Poor to fair; thin surface layer with caliche fragments	Fair; limited amount of material	Severe; shallow to indurated caliche and basalt	Moderate
2 Loma-Carnero-Tricon				
Loma silt loam	Good to a depth of 6 to 10 inches	Fair when mixed to a depth of 60 inches; moderate shrink-swell	Moderate to severe; slow permeability	Moderate
Carnero loam	Fair to good; 6 to 8 inches thick	Fair; moderate shrink-swell	Severe; moderate depth to bedrock	Moderate
Tricon silt loam	Fair to good; 3 to 7 inches thick	Poor; clayey material	Severe; caliche at 20 to 50 inches	Moderate
3 Colmor-Swastika-Berthoud				
Colmor loam	Fair; erodible calcareous	Poor; clayey material	Severe; slow permeability	Moderate
Swastika silt loam	Fair to good to a depth of 3 to 5 inches	Poor; clayey material	Severe; slow permeability	Moderate to hi
Berthoud loam	Fair to good surface layer; 10 to 12 inches thick	Fair; moderate shrink-swell	Slight to moderate	Low
4 LaBrier-Manzano-Loma				
LaBrier silt loam	Good to a depth of 5 to 8 inches	Poor; plastic; moderate to high shrink-swell	Severe; subject to flooding; slow permeability	Moderate
Manzano loam	Good to a depth of 8 to 10 inches	Fair to poor; moderately plastic	Moderate to severe; slow permeability; subject to overflow	Moderate
Loma silt loam	Good to a depth of 6 to 10 inches	Fair when mixed to a depth of 60 inches	Moderate to severe; slow permeability	Moderate
5 Remunda-Stroupe-Crews				
Remunda loam	Good to a depth of 10 inches	Poor to fair when mixed; moderate shrink-swell	Severe; slow permeability	Moderate
Stroupe-like cobbly sandy clay loam	Poor; stony	Poor; plastic material; stony	Severe; slow permeability	Moderate
Crews-like cobbly loam	Poor; stony	Fair; limited amount of material	Severe; shallow to caliche and shale	Moderate

Soil Features Affecting--				
		Farm ponds		Terraces, diversions,
Foundation support	Highway location	Reservoir area	Embankments	contour furrows and pitting
ıir bearing capacity; fair poor shear strength; high ırink-swell from 9 to 30 ches	Clayey subsoil layers with poor bearing value	Layers below 30 inches moderately permeable; may require compaction and sealing	Clayey materials from 9 to 30 inches; poor compaction characteristics	Dense clayey subsoil layers
ıir bearing capacity and ıear strength; rock at 30 60 inches	Basalt bedrock at 30 to 60 inches; occasional outcrop and some stones	Subject to seepage if excavated to bedrock	Clayey materials; poor compaction characteristics	Clayey subsoil layers; rock at 30 to 60 inches
allow to indurated caliche th good bearing capacity	Shallow to indurated caliche and basalt	Shallow to caliche; subject to seepage	Very limited amount of material	**
ıir bearing capacity; high ırink-swell	Clayey subsoil layers; high plasticity	*	Subsoil layers have poor compaction characteristics	Clayey subsoil layers with low intake
ıir bearing capacity and ıear strength	Fine-grained material; slight to medium plasticity	Subject to seepage; moderately deep	Fairly stable material; good if compacted	Moderately deep to bedrock; stable material if compacted
ıor to fair bearing capacy; caliche at 20 to 50 ches	Clayey subsoil layers; high plasticity	Caliche at 20 to 50 inches; if exposed may be subject to seepage	Clayey materials with poor compaction characteristics	Clayey subsoil layers
ıir bearing capacity and ıear; high compressibility	Moderate to high shrink-swell; potential frost heave	*	Clayey and silty materials; poor compaction characteristics	Erodible; channels subject to erosion and siltation
ıir to poor bearing capacy and shear strength	Clayey subsoil layers with high shrink-swell	*	Clayey material; poor compaction characteristics	Clayey subsoil layers with low intake layers
ıir to good bearing capacy; low to moderate shrink-vell	Fine-grained material; slight to medium plasticity	Moderately permeable; may require compaction	*	Moderately sloping
oderate to high shrink-vell; poor to fair bearing ıpacity	Subject to overflow; plastic materials	*	Clayey materials with poor compaction characteristics	Subject to overflow
ıir bearing capacity and ıear strength; moderate ırink-swell	Occasional flooding; moderately plastic material	*	Fair to good compaction characteristics and stability	Features generally favorable; occasional gully
ıir bearing capacity; high ırink-swell	Clayey subsoil layers; high plasticity	*	Clayey subsoil layers with poor compaction characteristics	Clayey subsoil layers
ıir to good bearing capacy below 3 feet; fair to poor ıaring capacity above 3 feet	Clayey subsoil layers with high plasticity	*	Clayey subsoil layers with poor compaction characteristics; fair compaction characteristics below 3 feet	Clayey subsoil layers
oderate to high shrink-vell; fair bearing capacity	Clayey and stony materials; unstable at high moisture content	Clayey and stony material; exposed stony and cobbly layers may be subject to seepage	Clayey and stony material; poor compaction characteristics	Undulating slopes; stony and clayey material
hallow to caliche; shale ıd siltstone	Shallow to caliche; caliche underlain by shale	Shallow to caliche and shale	Very limited amount of material	**

Table 7. Continued

Soil Map Symbol and Soil Association	Suitability as a Source of -- Topsoil	Roadfill	Degree of Limitation for Septic Tank Filter Fields	Corrosion Potentia (untreated steel pip
6 Bernal-Travessilla-Carnero				
Bernal fine sandy loam	Poor; thin sandy surface layer	Fair; limited amount of material	Severe; shallow to bedrock	Low
Travessilla stony loam	Poor; coarse fragments	Good to fair; material very limited	Severe; shallow to bedrock	Low
Carnero loam	Fair to good; 6 to 8 inches thick	Fair; moderate shrink-swell	Severe; moderate depth to bedrock	Moderate
7 Apache-Haxtun				
Apache stony loam	Poor; stony	Fair; limited amount of material	Severe; shallow to bedrock	Moderate
Haxtun-like stony loam	Poor; stony	Poor to fair; stony; bedrock at 20 to 40 inches	Severe; bedrock at 20 to 40 inches	Moderate
8 Penrose-Renohill-Midway				
Penrose loam	Poor; coarse fragments	Poor; shale and limestone substratum	Severe; shallow to shale and limestone	High
Renohill loam	Fair to a depth of 5 to 8 inches	Poor; clayey material	Severe; shale at 20 to 40 inches	Moderate to high
Midway loam	Poor to fair; 3 to 6 inches thick	Poor; shale substratum	Severe; shale at 10 to 20 inches	High
9 Bond-Fortwingate				
Bond stony loam	Poor; stony	Fair; limited amount of material	Severe; bedrock at 10 to 20 inches	Moderate
Fortwingate stony loam	Poor; stony	Poor; clayey subsoil layers	Severe; bedrock at 20 to 40 inches; steep slopes	Moderate
10 Rockland-Stony Land				
Rockland and stony land	(Interpretations not made)			
11 Rockland-Encierro-Carnero				
Rockland	(Interpretations not made)			
Encierro stony silty clay loam	Poor; stony and erodible	Poor; stony; silty and clayey subsoil layers	Severe; shallow to interbedded shale and sandstone	Moderate
Carnero-like loam	Good to a depth of 8 to 10 inches	Fair to poor	Severe; steep slopes	Moderate
12 Nambe-Cundiyo				
Nambe gravelly loam	Poor; gravelly and stony	Good; some stones	Severe; steep slopes	Low
Cundiyo gravelly sandy loam	Poor; gravelly and sandy	Good; moderate stone content	Severe; steep slopes	Low
13 Dargol-Stony Land				
Dargol stony loam	Poor; stony	Poor; clayey subsoil layers	Severe; shale and sandstone at 20 to 40 inches	Moderate
Stony land and rockland	(Interpretations not made)			

Soil Features Affecting --				
		Farm ponds		Terraces, diversions,
Foundation support	Highway location	Reservoir area	Embankments	contour furrows and pitting
llow to bedrock	Shallow to bedrock; moderately steep slopes	**	**	**
llow to bedrock	Shallow to bedrock; moderately steep slopes	**	**	**
r bearing capacity and ar strength	Fine-grained material; slight to medium plasticity	Subject to seepage; moderately deep	Fairly stable material; good if compacted	Moderately deep to bedrock; stable material
llow to bedrock	Shallow to bedrock	**	**	**
rock at 20 to 40 inches; ny material above bedk with fair bearing acity	Moderately deep to bedrock; stony and moderately plastic materials	**	Stony and moderately plastic materials; fair stability	**
llow to interbedded shale limestone	Undulating to rolling topography; shallow to shale and limestone	**	Limited amount of soil material; erodible; poor stability	**
r bearing capacity and ar strength; unstable at moisture content	Poor stability; shale at 20 to 40 inches	Moderately deep to shale; may be subject to seepage if shale is exposed	Clayey material; erodible; poor compaction characteristics	Undulating topography; subject to channel erosion and siltation
llow to shale; poor to bearing capacity	Undulating topography; shale at 10 to 20 inches; erodible	Shallow to shale; subject to seepage if shale is exposed	Poor stability and compaction characteristics	Unstable embankments; channels subject to siltation; difficult to vegetate
llow to bedrock	Steep hilly topography; shallow to bedrock; stones	**	Limited amount of soil material	**
lerately deep to bedrock; bearing capacity above ock	Moderately steep; moderate depth to bedrock; stones; some outcrop	Moderate depth to sandstone bedrock; subject to seepage	Clayey subsoil layers with fair compaction characteristics	Moderately steep slopes; bedrock at 20 to 40 inches
llow to interbedded shale sandstone	Steep slopes; rock outcrops; clayey subsoil layers	**	**	**
r to poor bearing capacand shear strength	Moderately steep slopes	Moderately permeable; may require compaction and sealing	Fair to good stability when compacted	Moderately steep slopes
d bearing capacity; fair ar strength; low shrinkll	Steep slopes and hilly topography; stony material	**	**	**
d bearing capacity; fair ar strength; low shrinkll	Steep slopes and hilly topography	**	**	**
r bearing capacity; poor ar strength; shale and stone at moderate depths	Steep slopes; rock outcrops; plastic materials	Interbedded shale and sandstone at 20 to 40 inches steep slopes	Plastic materials; poor compaction characteristics	Steep slopes**

Table 7. Continued

Soil Map Symbol and Soil Association	Suitability as a Source of -- Topsoil	Roadfill	Degree of Limitation for Septic Tank Filter Fields	Corrosion Potential (untreated steel pipe
14 Sinnigam-Barela-Burnac				
Sinnigam-like stony silt loam	Poor; stony	Fair; stony; limited amount of soil material	Severe; shallow to bedrock	Low to moderate
Barela silt loam	Good to a depth of 5 to 10 inches	Poor; clayey subsoil layers	Severe; bedrock 30 to 60 inches	Moderate
Burnac stony loam	Poor; stony	Poor; stony and clayey materials	Severe; steep slopes; bedrock at 40 to 60 inches	Moderate
Basalt Rockland	(Interpretations not made)			
15 Etown-Angostura				
Etown stony loam	Poor; stony	Fair to poor	Severe; steep slopes	Low to moderate
Angostura gravelly sandy loam	Poor; gravelly; some stones	Fair to good	Severe; steep slopes	Low
Loberg-like stony loam	Poor; stones	Fair to poor	Severe; steep slopes	Low to moderate
16 Gaines-Hayspur				
Gaines silty clay loam	Fair; silty and clayey	Poor; clayey material	Severe; very slow permeability	High
Hayspur-like loam	Good	Poor	Severe; high watertable; overflow hazard	Moderate
17 Vermejo-Remunda				
Vermejo silty clay loam	Poor; high clay content	Poor; clayey	Severe; very slowly permeable	High
Remunda sandy clay loam	Fair to a depth of 10 inches	Poor; clayey	Severe; slow permeability; watertable	Moderate
Carnero-like loam	Good to a depth of 8 to 10 inches	Fair to poor	Moderate; slopes moderately permeable	Moderate

*Soil features favorable
**Unsuitable or practices not applicable

ity, 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.

Soil Features Affecting--				
		Farm ponds		Terraces, diversions,
Foundation support	Highway location	Reservoir area	Embankments	contour furrows and pitting
hallow to basalt bedrock	Moderate slopes; shallow to bedrock; stones; outcrops	**	**	**
layey subsoil layers with igh shrink-swell and fair earing capacity	Clayey subsoil layers with poor compaction characteristics; bedrock at 30 to 60 inches	Features generally favorable; may be subject to seepage if basalt is exposed	Clayey subsoil layers with poor compaction characteristics	Clayey subsoil layers with slow permeability
air bearing capacity and hear strength	Steep slopes; some rock outcrops; stones	**	**	**
ood bearing capacity; steep lopes stony	Steep slopes and hilly topography; stones	**	**	**
ood bearing capacity; steep lopes; cobbly and stony	Steep slopes and hilly topography	**	**	**
ood bearing capacity; steep lopes; stones	Steep slopes and hilly topography	**	**	**
igh shrink-swell; poor hear strength	Plastic material; moderate overflow hazard; some high watertables	*	Clayey materials; poor compaction characteristics	Clayey material; subject to channel erosion
oor to fair bearing capacy; high watertables	Overflow hazard; high water tables and seep areas	*	Clayey materials with fair to poor compaction characteristics	High watertable and seep areas
oor bearing capacity; high hrink-swell	Clayey material with poor stability and bearing value; overflow	Very slow permeability; features generally favorable	Clayey material with poor compaction characteristics; difficult to vegetate	Subject to channel erosion and piping; cracks and drying
oor to fair bearing capacy and shear strength	Clayey subsoil layers with high plasticity; overflow and high watertables	Features favorable; slowly permeable	Clayey soil material with poor compaction characteristics	Clayey subsoil layers
air to poor bearing capacy and shear strength	*	Moderately permeable; may require compaction and sealing	Fair to good stability when compacted	Gently to strongly sloping and undulating

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