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NM-123, Part 2

Southern High Plains

By

W. C. Ballance and Frank B. Titus, JR.

#339

United States
Department of the Interior
Geological Survey
Albuquerque, New Mexico

Southern High Plains

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W. C. Ballance and Frank B. Titus, Jr.

(A contribution for incorporation in a State Planning Report to be prepared by the New Mexico State Engineer Office.)

Note: Changes on copy have been made on orange-backs

Prepared in cooperation with
the New Mexico State Engineer

December 1964

Contents

Illustrations

Tables

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Description

The Southern High Plains of New Mexico, 5,880 square miles in extent, is in the eastern part of New Mexico and is bordered on the east by Texas (fig. 1). Sub-areas within this major drainage area are the

Figure 1 (caption on next page) belongs near here.

Lea Plateau, Red River, and Brazos River.

Parts of counties included within the area are northern Lea, a narrow strip of eastern Chaves, all but the northwestern portion of Roosevelt, Curry, with the exception of the southwestern and extreme northern portions, and southeastern Quay.

The principal towns in the area are Hobbs, Lovington, and Tatum in Lea County; Portales in Roosevelt County; and Clovis in Curry County.

Figure 1.--Drainage basins of New Mexico.

Geography

The Southern High Plains in New Mexico consist of three drainage areas. The Red River drainage area, 2-1 on figure 1, is 685 square miles; the Brazos River drainage area, 2-2, is 695 square miles; the Lea Plateau area, 2-3, is 4,500 square miles.

The area has no permanent streams. A few intermittent streams may flow following thunderstorms, which are common during July and August. Most of the precipitation, however, soon infiltrates the soil or evaporates.

The Southern High Plains is in the Great Plains physiographic province which consists of broad intervalley remnants of smooth fluviatile plains (Fenneman, 1931).

Only a small part of the Southern High Plains has been topographically mapped. Figure 2 indicates the areas where mapping is completed,

Figure 2 (caption on next page) belongs near here.

the area in which mapping is progressing, and the areas in which no mapping has been done.

Figure 2.--Status of topographic mapping in New Mexico.

Geology

Rocks of Precambrian to Quaternary age underlie the Southern High Plains of New Mexico. (See table 1.) The rocks of Precambrian age, mostly of igneous and metamorphic origin, lie at depths considerably more than 10,000 feet below the surface. Rocks of the Ordovician to Permian Systems, having an aggregate thickness roughly estimated at 14,000 feet (Ash, 1963), overlie the Precambrian rocks but do not crop out in the area.

Red shales and sandstones of the Dockum Group of Triassic age underlie the entire area and are exposed locally in outcrops, especially in the central part of the area and around the perimeter of the High Plains. The group has a maximum thickness of about 1,800 feet in Lea County (Ash, 1963). Overlying the Triassic rocks unconformably are yellow clay, blue shale, and sandstone of the Tucumcari Formation of Cretaceous age. The Tucumcari Shale underlies the central part of the area and crops out locally. It reaches a maximum thickness of about 180 feet in Roosevelt County.

The Ogallala Formation of Tertiary (Pliocene) age crops out or is covered only by thin alluvial deposits over the entire area of the Southern High Plains except in Portales Valley. This formation has a maximum thickness of about 400 feet. In the Portales Valley erosion during the early Pleistocene removed the Ogallala, and the resulting valley was subsequently refilled with a deposit of alluvium that attains a maximum thickness of 200 feet or more. Elsewhere in the Southern High Plains the alluvium covering the Ogallala Formation is thin.

Soils and vegetation

Loose sandy soils are widely developed on the flat to rolling topography of the Southern High Plains (fig. 3). The soils develop

Figure 3 (caption on next page) belongs near here.

for the most part from weathering of sand and silt beds of the Cenozoic deposits that blanket the area. The entire area of the Southern High Plains is in the Upper Sonoran life zone (fig. 4). The vegetation

Figure 4 (caption on next page) belongs near here.

consists mostly of grasses, mesquite, yucca, and cactus.

Figure 3.--Soils resource map of New Mexico.

Figure 4.--Life zones of New Mexico.

Hydrology

Climatology

Weather stations are located at strategic points throughout the Southern High Plains. See figure 5 for weather station locations and

Figure 5 (caption on next page) belongs near here.

climatologic divisions. The Southern High Plains is included in the Northeastern Plains climatic zone. Mean temperatures and precipitation at the various weather stations are listed in table 2.

Figure 5.--Weather stations and climatologic divisions in New Mexico.

Table 2.--Mean temperature and precipitation at places in the Southern High Plains, New Mexico

(U.S. Weather Bureau, 1959)

Station	January		February		March		April		May		June		July		August		September		October		November		December		Annual	
	Temp. (°F)	Prec. (inches)	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.
Clovis	37.4	0.53	41.6	0.37	47.6	0.42	57.1	0.97	65.7	2.53	75.6	2.21	78.9	2.31	77.7	2.75	70.4	1.94	59.7	1.69	46.3	0.50	39.4	0.54	58.1	16.76
Elida	-	.39	-	.33	-	.43	-	.83	-	1.86	-	1.59	-	2.57	-	2.51	-	2.33	-	1.35	-	.41	-	.54	-	15.14
Floyd	-	.40	-	.23	-	.41	-	.73	-	2.27	-	1.77	-	2.47	-	2.12	-	1.85	-	1.43	-	.35	-	.56	-	14.59
Portales	37.2	.46	41.8	.34	48.2	.51	57.4	.81	65.5	2.39	74.9	2.25	77.6	2.70	76.4	2.93	69.4	1.96	58.9	1.39	45.7	.49	39.0	.57	57.7	16.80

Mean evaporation rates for two stations are listed in the following table (table 3). For more detailed information refer to the monthly and annual summary climatologic reports of the U.S. Weather Bureau, Department of Commerce.

Table 3.--Mean evaporation rates, in inches, 1960.

(U.S. Weather Bureau, 1960)

Station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
* Clovis 13N	-	3.59	7.89	10.78	13.34	13.59	11.93	10.67	7.81	5.88	4.82	-	-
Portales 7WNW	-	-	7.38	9.09	10.69	12.57	12.14	11.55	-	-	-	-	-

* Figures for 1960 only.

Surface water

The Southern High Plains has only one gaging station. The station is located on Running Water Draw near Clovis. The drainage area for Running Water Draw is 109 square miles. The peak discharge recorded at this station was on September 6, 1957, and amounted to 7,090 cfs (cubic feet per second) which is 65.0 cfs per square mile of drainage area.

Ground water

Only rocks of the Triassic, Cretaceous, Tertiary, and Quaternary systems are known to contain potable ground water. Permeable rocks of the Ordovician to Permian systems contain saline ground water. The only water known to have been pumped from these rocks has been the saline water produced along with oil.

Rocks of Triassic and Cretaceous age yield small to large quantities of generally potable water to many wells on the Southern High Plains. Small quantities of water are obtained by wells tapping the upper part of the Dockum Group of Triassic age in the central and northern parts of the area. The water comes from lenticular sandstones interbedded with the red shale constituting the major part of the stratigraphic sequence. The Tucumcari Shale of Cretaceous age in the Causey-Lingo area of Roosevelt County yields as much as 1,000 gpm (gallons per minute) to irrigation wells from sand and gravel at its base (Cooper, 1960, p. 14). The formation underlies the central part of the Southern High Plains area, but elsewhere the coarse basal member is thin and the formation generally yields only small quantities of water.

The Ogallala Formation and the overlying deposit of Quaternary alluvium comprise the Cenozoic stratigraphic sequence in the area. In most of the Southern High Plains area the two formations form a hydrologic unit. They are similar lithologically, and frequently it is difficult to distinguish one formation from the other. In the vicinity of Lovington, in the southern part of the area, yields as great as 1,700 gpm have been pumped from this combined aquifer (Ash, 1963). Yields of 1,000 gpm are common in the vicinity of Clovis to the north (Howard, 1954, table 1).

In the Portales Valley, one of the more intensively irrigated parts of the Southern High Plains, ground water for irrigation is derived solely from a thick section of the Quaternary alluvium where the alluvium fills the valley of an ancient stream that flowed east southeastward across the High Plains (Galloway, 1956). The alluvium in the Portales Valley yields more than 1,000 gpm to many wells.

The rock units constituting the important aquifers of the High Plains have been cut off from surrounding areas by the Recent erosion of the valleys of the Pecos and Canadian Rivers. Any recharge to the ground-water body can come only from infiltration of precipitation that falls on the High Plains (Theis, 1937).

Refer to the stratigraphic section in the Southern High Plains (table 1) for generalized physical properties and water-bearing characteristics of formations. Known and probable aquifers are designated by asterisks in the stratigraphic-unit column.

The quality of ground water varies in accordance with the solubility of the constituents of the various rocks through which the water flows. For this reason the quality of water varies from aquifer to aquifer and also, to a lesser extent, from one locality to another in the same aquifer. Table 4 indicates the general chemical quality of water yielded by a few selected wells in the Southern High Plains in New Mexico.

Table 4.--Analysis of water from selected wells

in the Southern High Plains, New Mexico.

Aquifer and location	Sulfate (ppm)	Chloride (ppm)	Conductance (micromhos at 25°C)	Total hardness (as $CaCo_3$)
Cretaceous rocks near Rogers	317	84	1,730	66
Ogallala near Rogers	32	24	564	316
Ogallala near Hobbs	823	845	4,070	1,400
Gravel near Lovington	69	33	716	281
Ogallala north of Clovis	42	8	428	169
Ogallala southwest of Clovis	-	32	543	207
Valley fill northwest of Portales	675	168	1,920	955
Triassic red beds southeast of Arch	1,860	3,290	12,700	395

Figures 6 and 7 indicate the distribution of quality of ground

Figure 6 (caption on next page) belongs near here.

Figure 7 (caption on next page) belongs near here.

water in New Mexico. Potable ground water is generally available throughout the area of the Southern High Plains. At a few localities, however, shallow ground water from Triassic or Cretaceous age rocks may contain somewhat more than the recommended maximum of 250 ppm (parts per million) of either sulfate or chloride.

The U.S. Geological Survey measures water levels periodically in a network of observation wells in areas where ground water is being used in large quantity for irrigation, municipal, and industrial purposes. These measurements, with water-level changes, are published each year in the State Engineer Technical or Basic-Data reports. The areas in which water levels are measured in New Mexico are indicated on figure 8.

Figure 8 (caption on next page) belongs near here.

Figure 9 indicates the change in water level for the period 1940-60

Figure 9 (caption on next page) belongs near here.

in the Tatum-Lovington-Hobbs area. Figure 10 indicates the change in

Figure 10 (caption on next page) belongs near here.

water level in Portales Valley for the period 1933-60.

Table 5 is an estimate of the acres irrigated and water pumped on the Southern High Plains for the period 1936-55.

Ground-water studies are constantly being made in New Mexico by State and Federal agencies. Figure 11 illustrates the areas in New

Figure 11 (caption on next page) belongs near here.

Mexico where ground-water investigations have been made.

Table 5.-- Estimated acres irrigated and ground water pumped for irrigation, in acre-feet by years, in the Portales Valley and the Tatum-Lovington-Hobbs areas, Southern High Plains, Roosevelt County, New Mexico.

Year	Portales Valley Roosevelt County		Tatum-Lovington-Hobbs area Roosevelt County	
	Irrigated area (acres)	Water pumped (acre-feet)	Irrigated area (acres)	Water pumped (acre-feet)
1936	11,000	22,000	-	-
1937	11,000	22,000	1,500	1,800
1938	11,000	16,500	1,850	1,700
1939	13,000	19,500	2,400	2,200
1940	13,700	25,800	2,950	3,200
1941	15,000	9,750	2,600	1,550
1942	15,700	23,500	3,000	3,500
1943	17,000	45,000	3,200	6,000
1944	20,500	23,500	3,400	3,500
1945	22,000	37,500	3,800	6,500
1946	24,500	37,000	5,000	3,500
1947	28,000	45,000	9,300	19,000
1948	32,000	37,000	25,000	39,000
1949	37,000	37,000	71,000	60,000
1950	43,000	52,000	89,000	95,000
1951	47,000	84,000	91,000	153,000
1952	48,000	82,000	92,000	166,000
1953	49,000	101,000	92,600	165,000
1954	50,000	108,000	93,000	163,000
1955	50,750	95,000	93,000	170,000

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Table 2.--Mean temperature and precipitation at places in the Southern High Plains, New Mexico

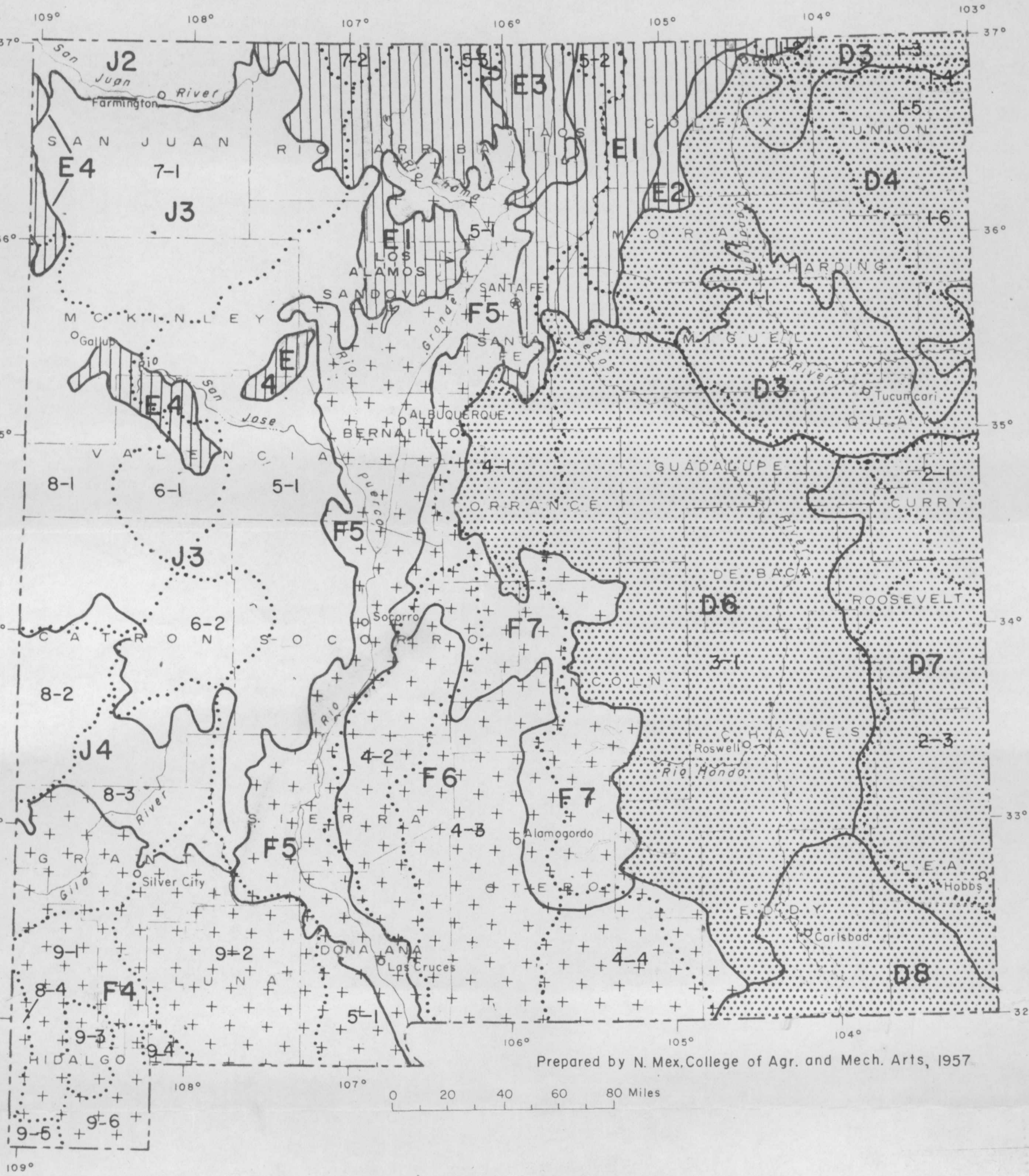
(U.S. Weather Bureau, 1959)

Station	January		February		March		April		May		June		July		August		September		October		November		December		Annual	
	Temp. (°F)	Prec. (inches)	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.	Temp.	Prec.
Clovis	37.4	0.53	41.6	0.37	47.6	0.42	57.1	0.97	65.7	2.53	75.6	2.21	78.9	2.31	77.7	2.75	70.4	1.94	59.7	1.69	46.3	0.50	39.4	0.54	58.1	16.76
Elida	-	.39	-	.33	-	.43	-	.83	-	1.86	-	1.59	-	2.57	-	2.51	-	2.33	-	1.35	-	.41	-	.54	-	15.14
Floyd	-	.40	-	.23	-	.41	-	.73	-	2.27	-	1.77	-	2.47	-	2.12	-	1.85	-	1.43	-	.35	-	.56	-	14.59
Portales	37.2	.46	41.8	.34	48.2	.51	57.4	.81	65.5	2.39	74.9	2.25	77.6	2.70	76.4	2.93	69.4	1.96	58.9	1.39	45.7	.49	39.0	.57	57.7	16.80

Table 1.--Generalized stratigraphic section in the Southern High Plains, New Mexico

(* Known or probable aquifer, regardless of areal extent or production potential.)

System	Stratigraphic Unit	Thickness (feet)	Distribution	Physical properties	Water-bearing characteristics
Quaternary	* Alluvium	0 to 200±	Attains greatest thickness ~~only~~ in Portales Valley. Crops out extensively on and at edges of High Plains, where it is up to 40 feet thick.	Sand, silt, clay, with gravel generally at base. Mostly poorly consolidated, but contains one or more caliche beds.	In Portales Valley many wells produce more than 1,000 gpm. Elsewhere yields small quantities of water where not above water table.
Tertiary	* Ogallala	0 to 400, averages about 200	Crops out or underlies alluvium throughout entire area except in Portales Valley where removed by early Pleistocene erosion preceding Quaternary alluviation.	Sand, silt, clay, with fine gravel generally near base. Mostly poorly consolidated. Contains many caliche beds; caliche at present land surface well developed.	Good aquifer where saturated thickness is adequate. Has yielded more than 1,000 gpm to wells in Curry Co., up to 1,700 gpm to wells in Lea Co.
Cretaceous	* Tucumcari Shale	0 to 180	Crops out locally south of Portales Valley; underlies Cenozoic strata in Roosevelt Co. south of Portales Valley and in northeast third of Lea Co. Thickest in southeast Roosevelt Co.	Upper member yellow clay, silt with thin sandstone and limestone; lower member blue shale thin sandstone and limestone; sand and gravel in erosion channels at base is up to 100+ feet thick.	Sand and gravel unit at base yields small to locally large quantities of water; wells in Causey-Lingo area, Roosevelt County tested as high as 1,200 gpm.
Triassic	* Dockum Group	1,000(?) to 1,800	Underlies entire area. Crops out locally in High Plains and extensively around edges.	Upper part red shale with lenticular sandstone and limestone interbedded, up to 1,200 ft thick; lower part sandstone with red shale, up to 600 ft thick.	Small quantities of water pumped for stock, domestic use; not everywhere reliable aquifer. Lower unit might yield small quantities of potable water if tested.
Permian	-	8,000±	Underlies entire area.	5,000 feet of predominantly dolomite and limestone, overlain by 3,000 ft of salt and anhydrite.	Permeable units contain only highly saline water.
Ordovician to Pennsylvanian	-	3,000 to 6,000	do.	Limestone, dolomite, shale, sandstone	Do.
Precambrian	-	-	do.	Granite and volcanic rocks.	Probably contains little or no water.



D_3 Generally shallow soils in steeply rolling and rough broken areas. Moderately deep and deep soils in valley bottoms and alluvial fans.

D_4 Largely moderately deep to deep, medium to heavy-textured soils interspersed with some areas of shallow soils; generally gently rolling topography.

D_6 Dominantly moderately deep to deep, medium-textured soils with rolling topography, interspersed with areas of shallow soils and deep sandy soils with dune-like topography.

D_7 Generally loose sandy soils with dune-like topography east of Pecos river, interspersed with areas of shallow to moderately deep, medium to heavy-textured soils west of Pecos river.

D_8 Similar to D-7, east of Pecos river, interspersed with areas of shallow to moderately deep, medium-textured soils west of Pecos river.

E_1, E_2, E_3, E_4 Largely shallow to moderately deep, light to medium-textured soils with rolling to mountainous topography. Generally shallow soils on escarpments and mountainous areas.

F_4 Generally light to medium-textured, deep and shallow soils with rolling topography, interspersed with low mountains. Dominantly shallow soils and rock outcrops in mountainous areas.

F_5 Large areas of light to medium-textured, shallow to moderately deep soils with gentle to moderate slopes.

F_6 Mesas, benchlands, and mountain slopes. Largely light to medium-textured, shallow to moderately deep soils on mesas and benchlands, and gravelly shallow soils on mountain slopes and foothills.

F_7 Largely mountain ranges and foothill slopes. Dominantly medium-textured soils on mountain slopes, and moderately deep to deep soils on foothill slopes.

J_2 Dominantly medium-textured, shallow soils on steep slopes. Medium-textured moderately deep soils on sloping plains, and dissected mesas; and medium to heavy-textured deep soils in valleys.

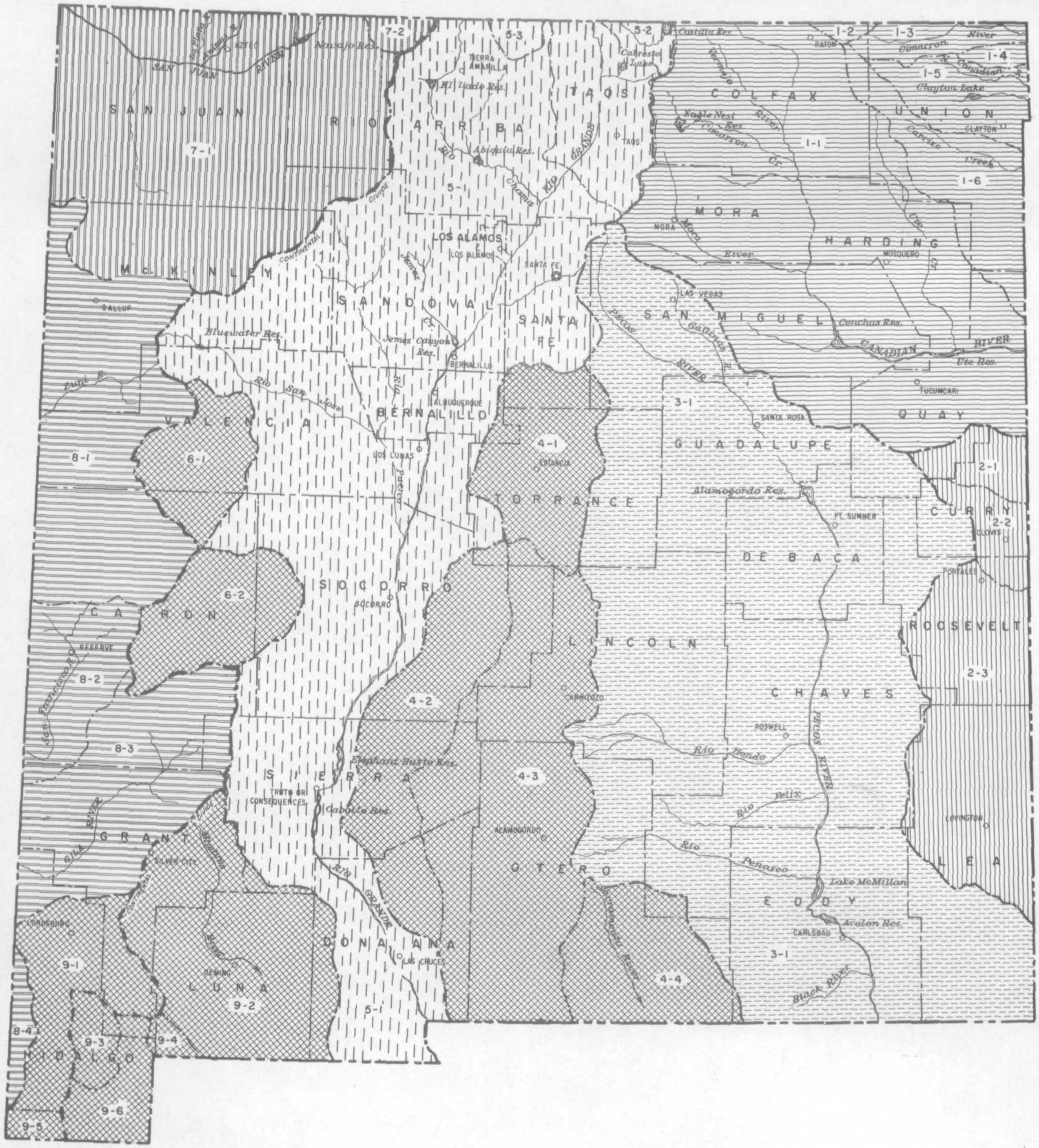
J_3 Largely medium-textured, moderately deep to shallow soils interspersed with areas of light-textured soils. Generally rolling topography with steep slopes in mountainous areas.

J_4 Generally mountainous shallow soils interspersed with rock outcrops and small areas of moderately deep soils. Generally mountainous topography.

2-1

Outline of river basins

Fig 3 — Soils resource map of New Mexico



0 5 10 20 30 40 50 60 70 80 90 100
SCALE IN MILES

BASIN INDEX

ARKANSAS RIVER BASIN
1-1, CANADIAN RIVER
1-2, PURGATOIRE RIVER
1-3, CIMARRON RIVER
1-4, CARRIZOZO CREEK
1-5, NORTH CANADIAN RIVER
1-6, CARRIZO CREEK

SOUTHERN HIGH PLAINS
2-1, RED RIVER
2-2, BRAZOS RIVER
2-3, LEA PLATEAU

PECOS RIVER BASIN
3-1, PECOS RIVER

CENTRAL CLOSED BASINS
4-1, ESTANCIA BASIN
4-2, JORNADA DEL MUERTO BASIN
4-3, TULAROSA BASIN
4-4, SALT BASIN

RIO GRANDE BASIN
5-1, RIO GRANDE
5-2, COSTILLA CREEK
5-3, RIO SAN ANTONIO

WESTERN CLOSED BASINS
6-1, NORTH PLAINS
6-2, SAN AUGUSTIN PLAINS

SAN JUAN RIVER BASIN
7-1, SAN JUAN RIVER
7-2, NAVAJO RIVER

LOWER COLORADO RIVER BASIN
8-1, LITTLE COLORADO RIVER
8-2, SAN FRANCISCO RIVER
8-3, GILA RIVER
8-4, SAN SIMON CREEK.

SOUTHWESTERN CLOSED BASINS
9-1, ANIMAS BASIN
9-2, MIMBRES BASIN
9-3, PLAYAS BASIN
9-4, WAMEL BASIN
9-5, SAN LUIS BASIN
9-6, HACHITA BASIN

FIGURE 1
DRAINAGE BASINS
OF
NEW MEXICO

P 2

Fig 2A/ Topographic mapping in New Mexico

Status of

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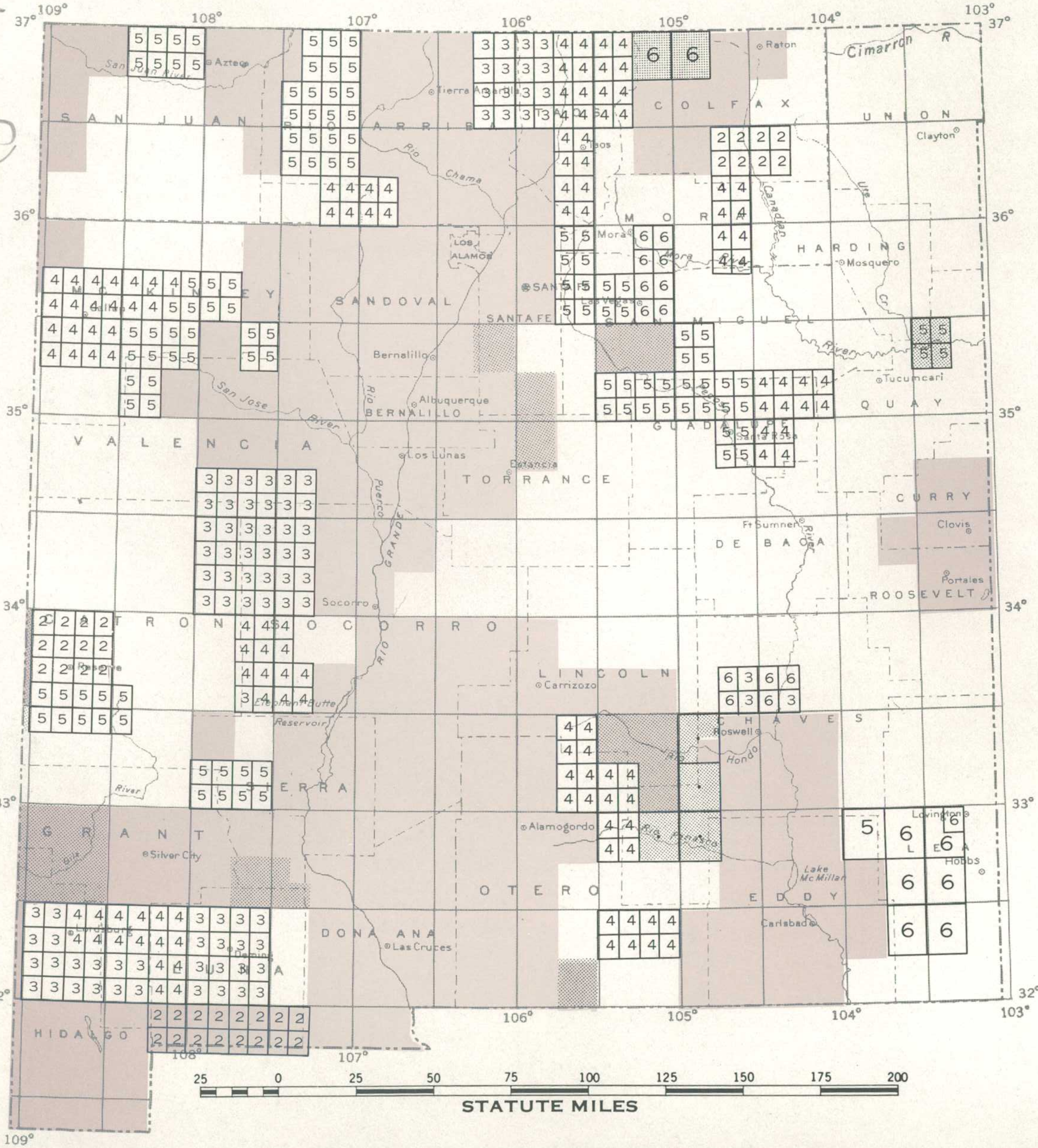
GEOLOGICAL SURVEY

NEW MEXICO

TOPOGRAPHIC DIVISON
ROCKY MOUNTAIN AREA
DENVER, COLORADO
OCTOBER 1, 1964



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3 — Basic horizontal and vertical control surveys completed. Descriptions and unadjusted coordinates and/or elevations are available. Price 50 cents for each 15-minute quadrangle horizontal or vertical control list. See notes.

P 4 — Prints of manuscripts compiled from aerial photographs are available at 50 cents each. Contours are shown in areas suitable for stereocontouring. Letter "P" indicates quadrangles on which contouring is not complete and which will require fieldwork to complete the contouring. (If shaded, see explanation below.)

5 — Field mapping and checking completed. One-color advance prints (without names) available for 50 cents each. (If shaded, see explanation below.)

6 — Final drafting completed. Partially-edited one-color advance prints (with names) available for 50 cents each. (If shaded, see explanation below.)

· — Maps published since latest edition of Index to Topographic Mapping— May, 1964. See statement below regarding published maps. (If shaded, see explanation below.)

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NOTES

1. Send requests for control lists and advance prints to U.S. Geological Survey, Topographic Division, Federal Center, Bldg. 25, Denver, Colorado, 80225. Check, money order or draft in correct amount made payable to U.S. Geological Survey should accompany order. Please do not send stamps. No discount allowed.

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Fig 3

LEGEND

HUDSONIAN AND ARCTIC ZONE

CANADIAN ZONE

TRANSITION ZONE

UPPER SONORAN

LOWER SONORAN

FIGURE ~~7~~ 3c 4

~~MAP SHOWING~~

~~THE~~ LIFE ZONES OF NEW MEXICO

ADAPTED FROM

NORTH AMERICA FAUNA NO. 35

LIFE ZONES AND CROP ZONES OF NEW MEXICO

VERNON BAILEY, 1913, U.S. DEPARTMENT OF AGRICULTURE

DRAWN BY M.B. HUEY

JULY 1956

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SCALE IN MILES

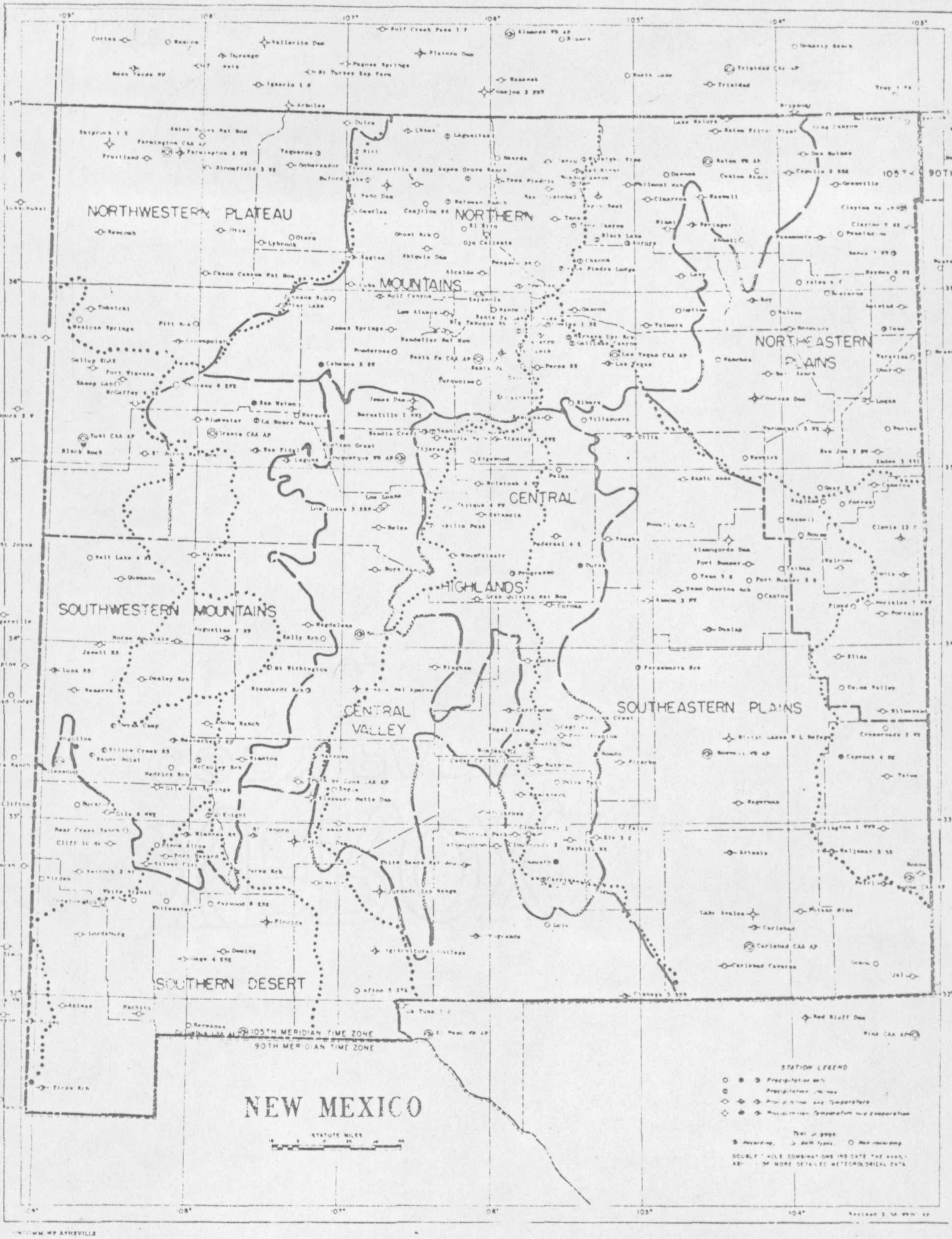

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Figure 5 4.— ~~Location of~~ Weather stations and Climatologic ~~zones~~ divisions in New Mexico

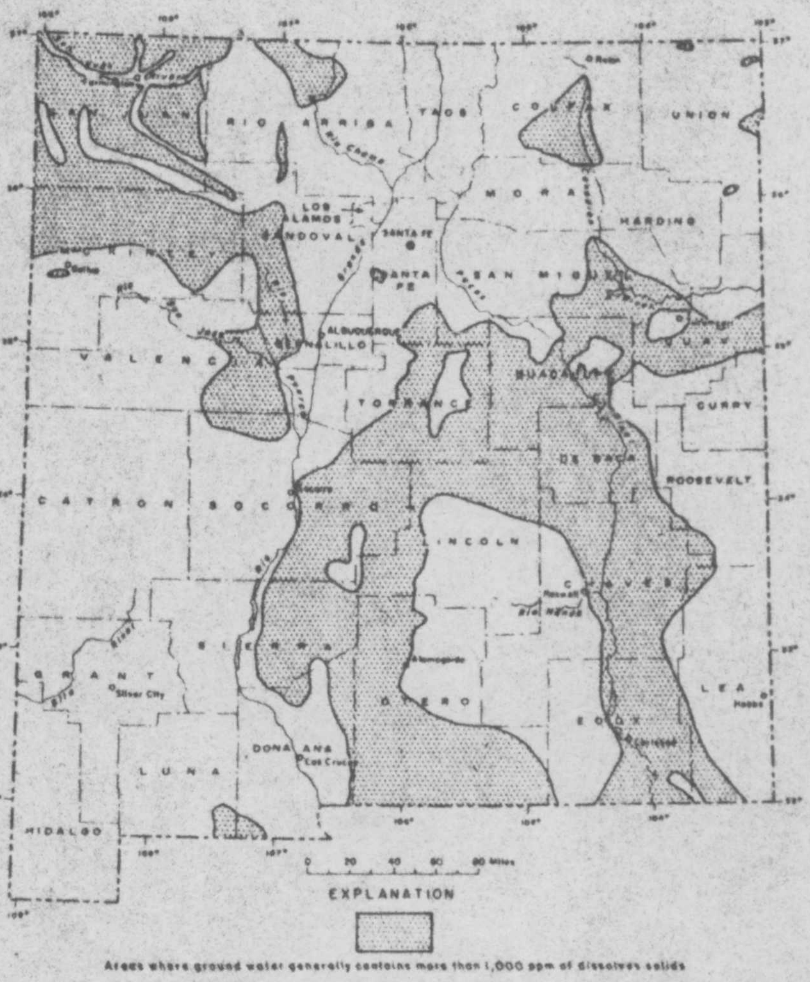
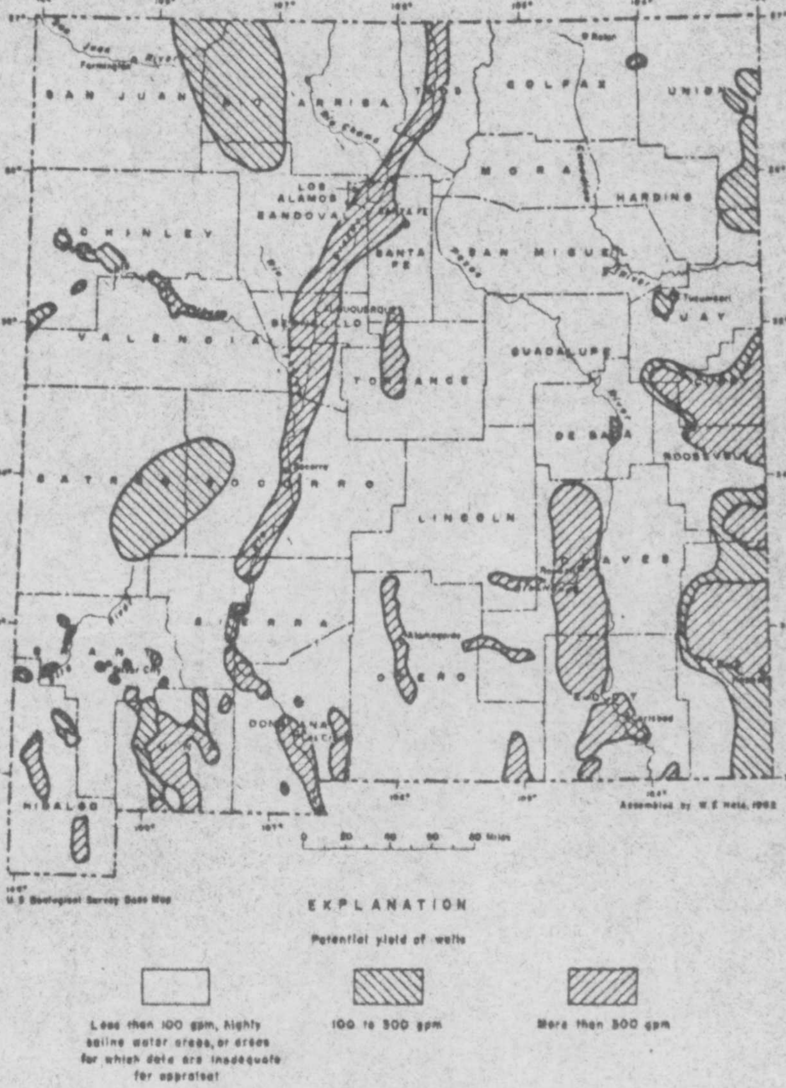


Figure ~~17~~ ~~5~~ 6.--General quality of shallow ground water in New Mexico



Small Moderate Large

Figure ~~8~~ 7.--General availability of relatively fresh ground water in New Mexico

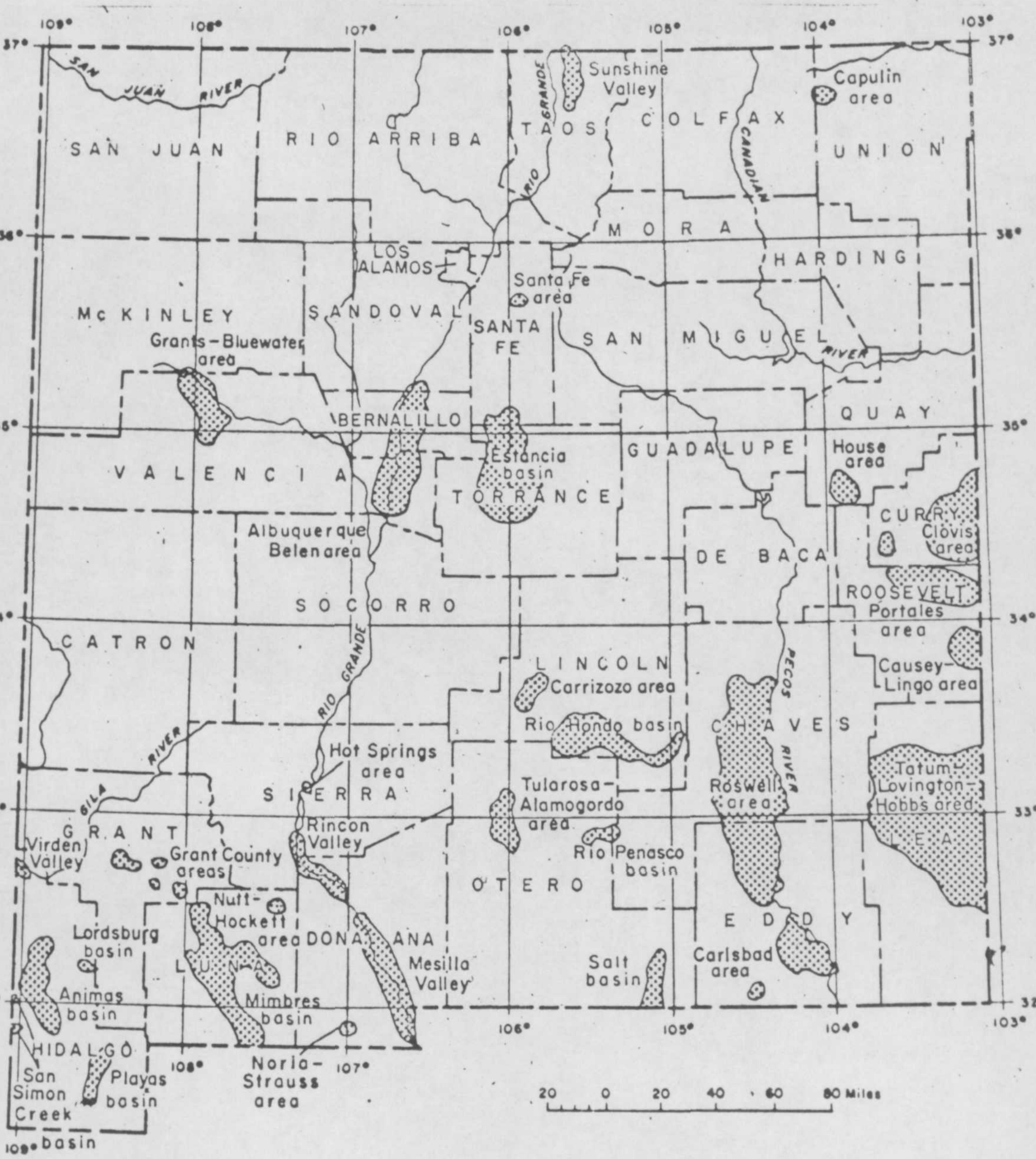


Fig. 8 - Areas of observation of water levels in New Mexico.

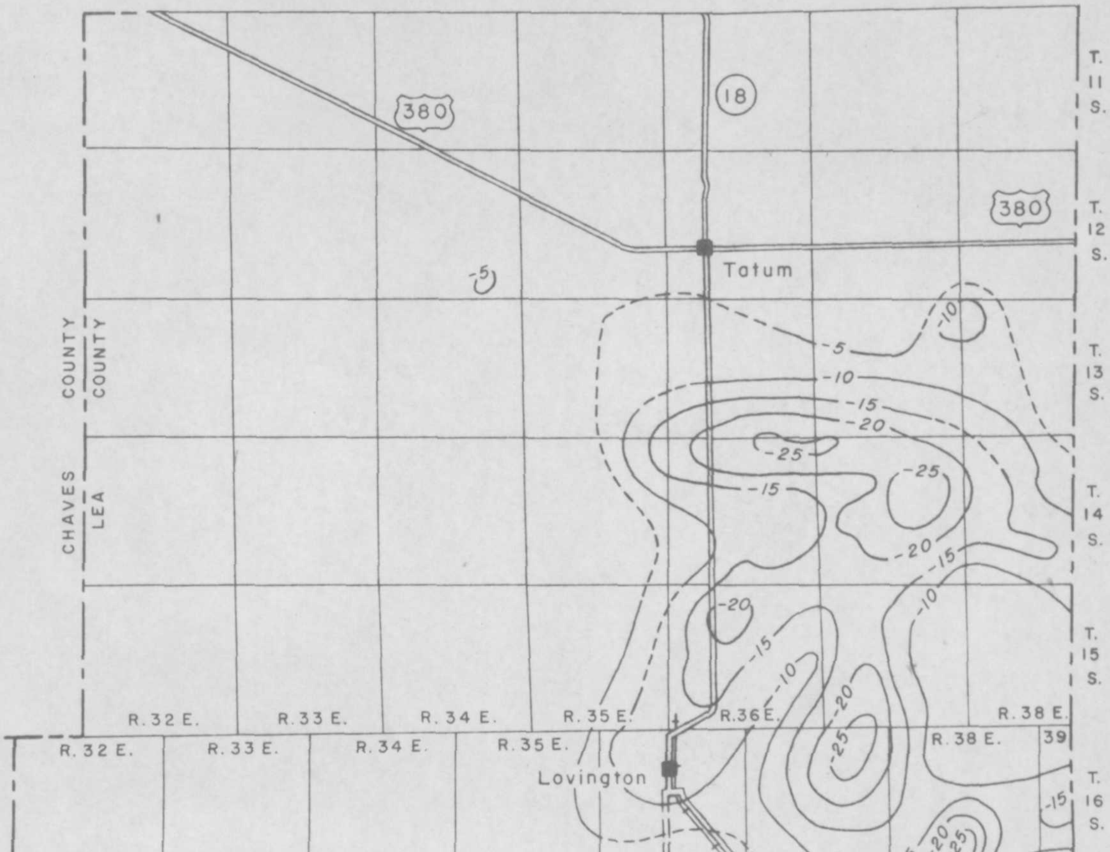


Figure ~~87~~ 89.--Decline of ground-water level in Tatum-Lovington-Hobbs area of the Southern High Plains, Lea County, New Mexico, for the period 1940-60.

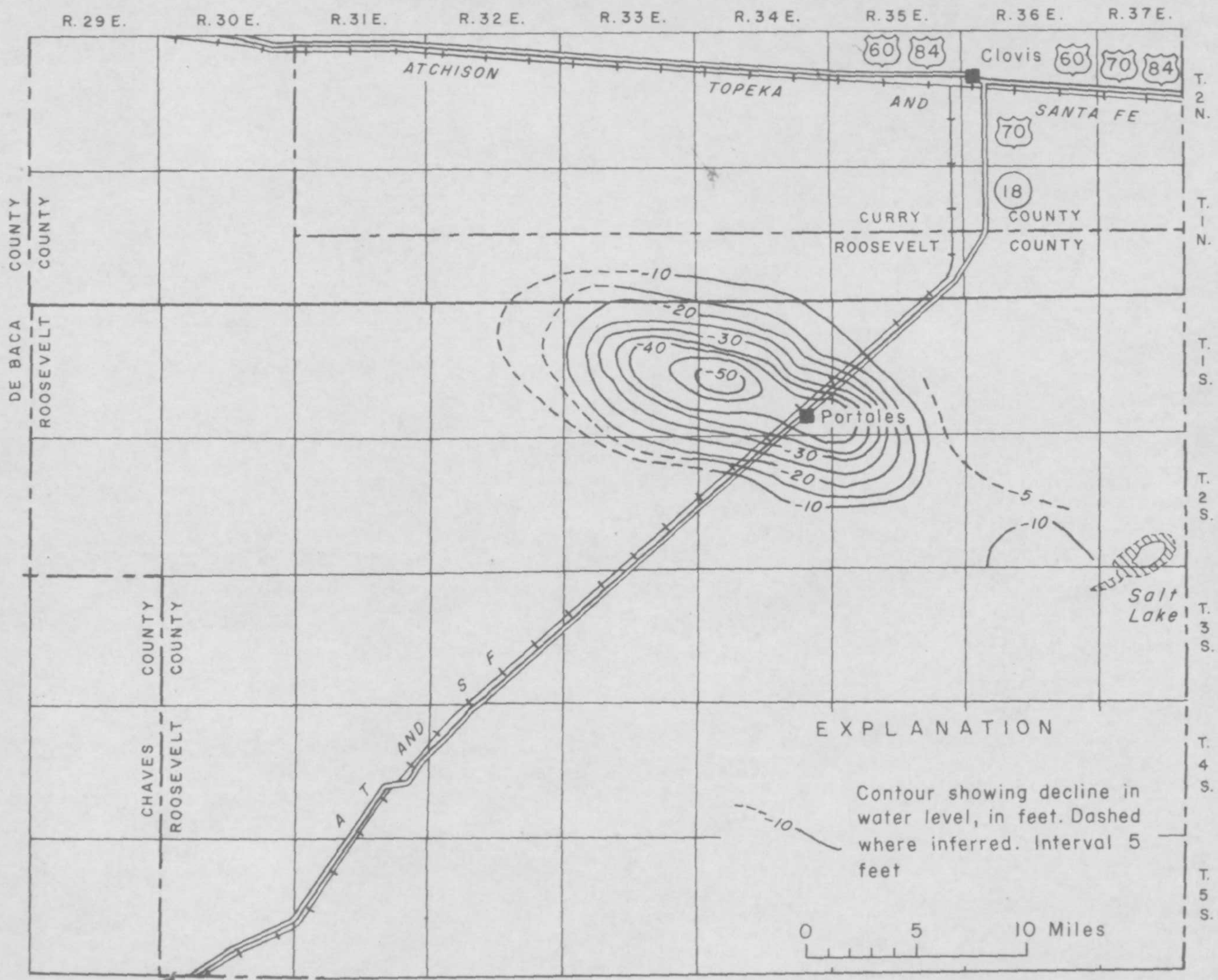


Figure 36.--Decline of ground-water level in Portales Valley, Roosevelt County, New Mexico, for the period 1932-60.

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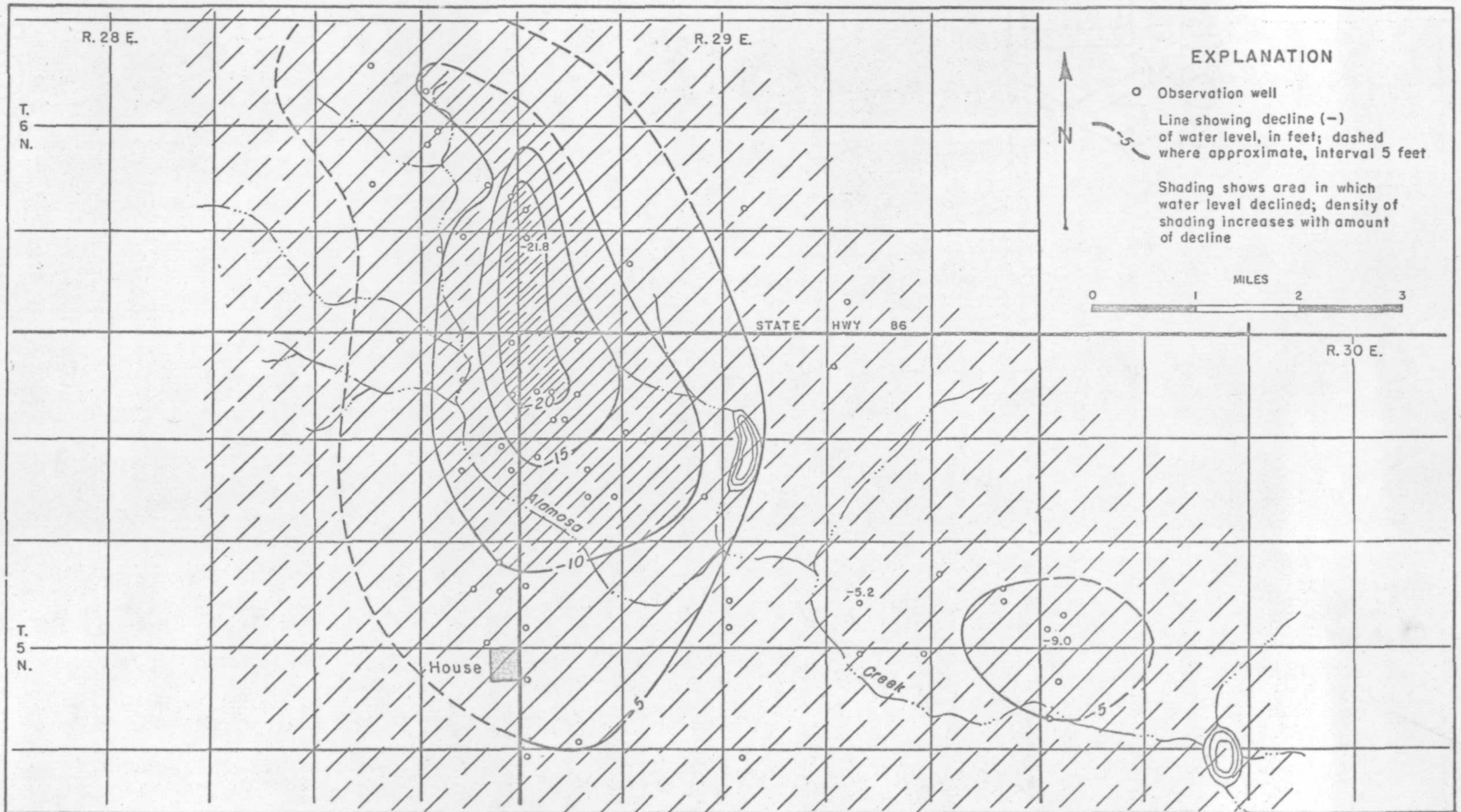

FIGURE ~~4.~~ 10A -- Change Decline of ground-water level ~~from January 1950 to January 1960~~ in the House area, Quay County, N. Mex., for the period 1950-60

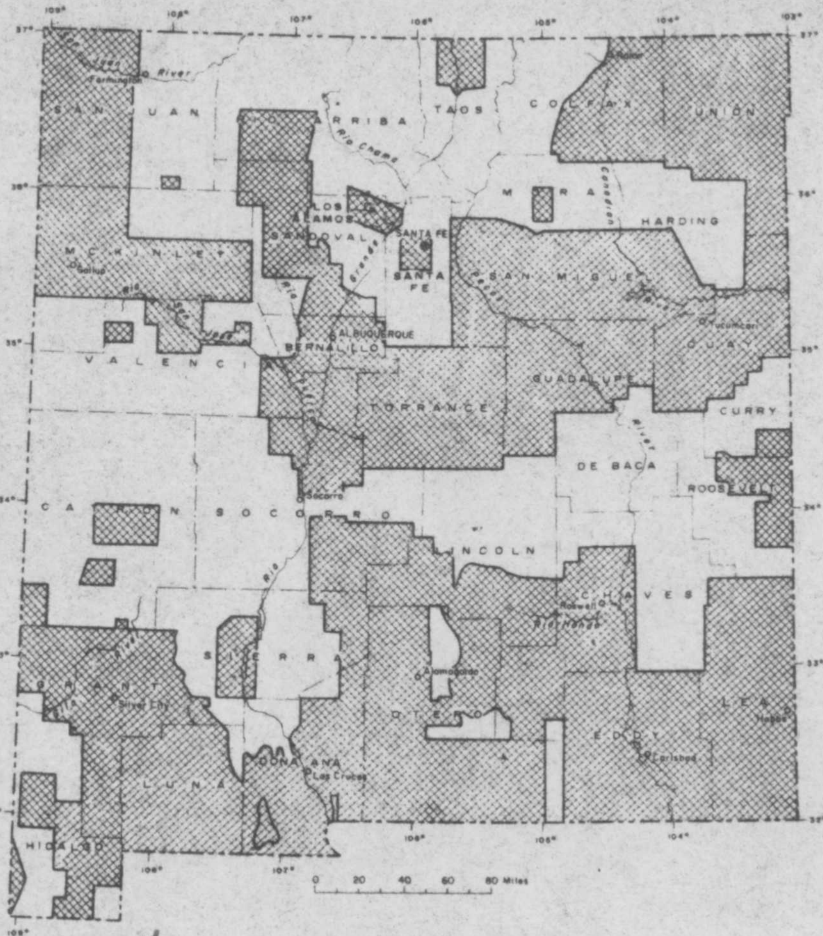

Figure ~~10~~ 11.--Areas in New Mexico in which ground-water studies have been made.