QUALITY OF GROUND WATER IN AGRICULTURAL AREAS OF THE SAN LUIS VALLEY, SOUTH-CENTRAL COLORADO

By Patrick Edelmann and David R. Buckles

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 83-4281

Prepared in cooperation with the

RIO GRANDE WATER CONSERVATION DISTRICT

Lakewood, Colorado
1984

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ILLUSTRATIONS

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METRIC CONVERSION FACTORS

Inch-pound units used in this report may be converted to International System of Units (SI) by using the following conversion factors:

Multiply inch-pound unit	*By*	*To obtain SI unit*
acre	4.047	square kilometer
acre-foot per year	1,233	cubic meter per year
acre-inch	102.8	cubic meter
cubic foot per second	0.02832	cubic meter per second
foot	0.3048	meter
inch	25.4	millimeter
pound	453.6	gram
pound per acre-inch	4.414	gram per cubic meter
square mile	2.590	square kilometer
micromho per centimeter at 25° Celsius (μmho/cm)	1.00	microsiemens per meter at 25° Celsius (μS/m)

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level.

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ABSTRACT

The quality of ground water in the principal agricultural areas of the San Luis Valley, south-central Colorado was evaluated using chemical analyses of water collected from 57 wells completed in the unconfined aquifer and from 25 wells completed in the confined aquifer. Ground water in both aquifers generally contains dissolved-solids concentrations of less than 500 milligrams per liter. In most areas, calcium is the predominant cation in the ground water. Nitrite plus nitrate concentrations, expressed as nitrogen, generally are less than 1 milligram per liter. However, the quality of ground water in certain areas may pose health and agricultural hazards.

Water in the unconfined aquifer near Center contains excessive nitrite plus nitrate, as nitrogen, concentrations. The highest measured concentration in this area was 33 milligrams per liter. Water containing more than 1 milligram per liter of nitrite, as nitrogen, or 10 milligrams per liter nitrate, as nitrogen, poses a potential health hazard for infants and should not be used as a source of their drinking water. In addition, dissolved-solids concentration in the ground water in some areas is greater than 500 milligrams per liter and, if used for irrigation, may reduce crop yields.

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INTRODUCTION

The Investigation Describes the Chemical Quality of the Ground Water in the Principal Agricultural Areas of the San Luis Valley

The purposes of this investigation were to describe the chemical quality of the ground water in the principal agricultural areas of the San Luis Valley and to assess temporal trends in the quality of ground water. The U.S. Geological Survey began the investigation in 1980, in cooperation with the Rio Grande Water Conservation District. The scope of investigation included: (1) Evaluating all existing hydrologic, ground-water, water-quality, and geologic data for the study area, (2) collecting and analyzing water samples from 57 wells completed in the unconfined aquifer and 25 wells completed in the confined aquifer, and (3) where possible, selecting wells based on quality of well-construction data and geographic location.

The authors wish to thank Ralph G. Curtis and Fredrick W. Huss of the Rio Grande Water Conservation District for their assistance and many helpful suggestions during the investigation. Special appreciation is extended to the irrigators, residents, and landowners in the San Luis Valley who permitted the collection of data.

PHYSICAL AND GEOLOGICAL SETTING

The 1,400-Square-Mile Study Area Comprises an Estimated 70 Percent of the Combined Irrigated Cropland in Saguache, Rio Grande Alamosa, and Conejos Counties

The study area is in the San Luis Valley, Colo. (fig. 1), and has an area of approximately 1,400 square miles. This area comprises an estimated 70 percent of the combined irrigated cropland in Saguache, Rio Grande, Alamosa, and Conejos Counties.

The San Luis Valley is a high, arid mountain basin between the San Juan and Sangre de Cristo Mountains. The valley has an average altitude of about 7,700 feet and an area of approximately 3,200 square miles. Water in the southern one-half of the valley flows towards the Rio Grande and its tributaries. North of the Rio Grande a drainage divide (fig. 1) forms the southern boundary of the closed basin, an area of interior drainage.

The valley floor is underlain by valley-fill deposits that consist of unconsolidated clay, silt, sand and gravel, and interbedded volcanic rocks. The alluvial deposits are coarse and permeable near the mountains and become finer grained, and less permeable toward the center of the valley. Most of the valley-fill deposits contain water. A series of clay lenses or an upper layer of volcanic rocks separate the valley-fill deposits into unconfined and confined aquifers. Where the clay lenses are discontinuous, water leaks upward from the confined aquifer into the unconfined aquifer.

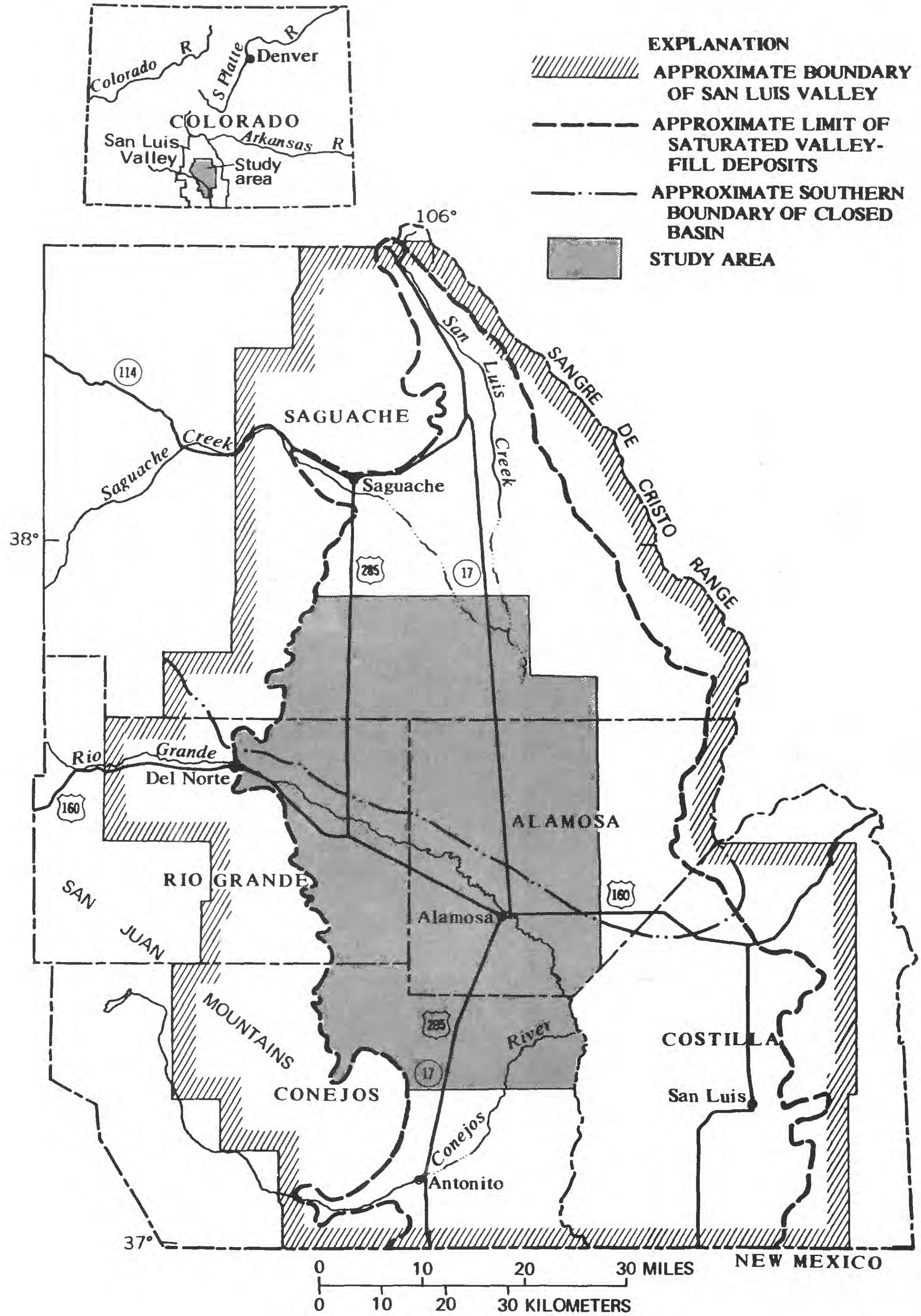

Figure 1.--Location of study area.

LAND AND WATER USE

The Primary Use of the Land and Water Is Agriculture

Land-use within the study area is mainly agricultural, and the principal enterprises are farming and ranching. The main crops produced are potatoes, barley, alfalfa, oats, lettuce, and meadow hay. The major livestock production is cattle and sheep.

The primary use of surface and ground water in the valley is for irrigating farm lands. The surface water is applied to the irrigated land by gravity drainage. Irrigation also supplies recharge to the valley's aquifers, which are tapped by wells used for municipal, domestic, stock, industrial, and irrigation purposes. Not all the water used in the valley is consumed; part returns to the streams or infiltrates to the ground-water system where it is available for reuse.

Surface-water diversions from the Rio Grande vary considerably from year to year. Between 1973 and 1979, diversions from the Rio Grande have varied from approximately 251,000 to 686,000 acre-feet per year (T. M. Crouch, U.S. Geological Survey, written commun., 1981). Pumpage records indicate an increase in ground-water withdrawals (G. A. Hearne, U.S. Geological Survey, written commun., 1981), which may be related to a change in irrigation practices since 1973. The number of sprinkler-irrigation wells has increased from 262 in 1973 to 1,724 in 1981. Davis (1980, p. 12) reports that crop-irrigation demand is approximately 6 percent greater when sprinkler irrigation is used than when surface irrigation is used.

PREVIOUS INVESTIGATIONS

Concern about the Chemical Quality of Ground Water in the San Luis Valley Began As Early As 1893

Concern about the chemical quality of ground water in the San Luis Valley began as early as 1893--about 6 years after wells were first drilled in the valley. Reports from investigations concerned with ground-water quality have been authored by Holmes (1903), Siebenthal (1910), Scofield (1938), Powell (1958), and Emery and others (1973).

Emery and others (1973) inventoried the water resources in the valley and collected water-quality samples from 400 wells. Water samples collected from wells completed in the unconfined aquifer and confined aquifer were analyzed for chemical constituents. Emery and others (1973) concluded that the chemical quality of water in the unconfined aquifer was suitable for most uses near the boundary of the valley-fill deposits but had a high salinity and alkali hazard in the central part of the valley. Water pumped from the unconfined aquifer in the extensively irrigated areas near Center had dissolved nitrate as nitrate concentrations, as much as 65 milligrams per liter. Emery and others (1973) surmised that the nitrate concentrations in the ground water were a result of significant applications of chemical fertilizers. Ground water in the confined aquifer also had a high salinity and alkali hazard in the central part of the valley.

GROUND WATER

Water in the Unconfined and Confined Aquifer Generally Moves Towards the Center of the Valley

Ground water in the San Luis Valley is in two aquifer systems--the unconfined and the confined. Water in the unconfined aquifer moves towards the center of the valley, and the depth to water generally is less than 12 feet below land surface (fig. 2). Movement of the unconfined ground water north of the closed basin's southern boundary (fig. 2) is generally considered to be contained and does not discharge to the Rio Grande.

The unconfined aquifer is recharged by streamflow, surface-water runoff along the rim of the valley, irrigation, and upward leakage from the confined aquifer (Powell, 1958, p. 62). The altitude of the water-table generally is highest between late winter to early spring and lowest between mid- to late summer. However, during an investigation of streamflow depletion in the Conejos River, E. L. Nickerson (U.S. Geological Survey, oral commun., 1982), observed that the water table is highest between late spring to early summer and lowest during the fall in the southwestern part of the valley. Apparently, less pumpage from the unconfined aquifer in Conejos County and increased recharge from applied surface-water irrigation during late spring cause the water table to rise.

Water in the confined aquifer also moves towards the center of the valley. Recharge to the confined aquifer is by streamflow and precipitation along the rim of the valley where the confining layers are absent or ineffective. The hydraulic head in the confined aquifer is generally highest during the winter and lowest during the summer (E. L. Nickerson, U.S. Geological Survey, written commun., 1982).

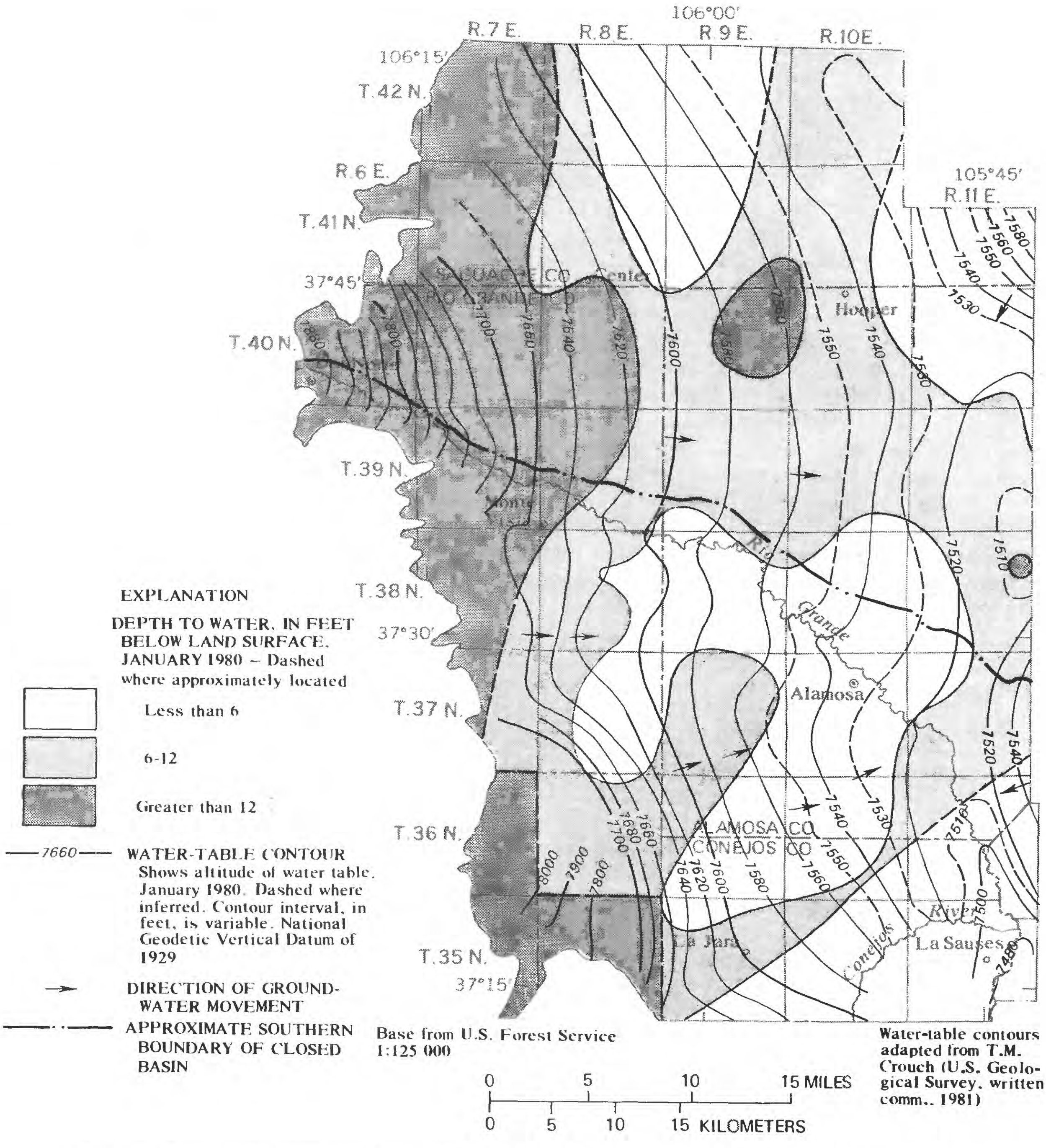

Figure 2.--Depth to water, altitude of water table, and direction of ground-water movement in the unconfined aquifer, January 1980.

WATER QUALITY

The Chemical Quality of Ground Water in the Valley Is the Result of Both Natural and Manmade Processes

The chemical quality of ground water in the valley is the result of both natural and artificial (manmade) processes that change the chemistry of the water as it moves through the valley. A summary of the cause-and-effect relations of the major processes affecting water quality is presented in table 1.

As water enters the valley, the natural processes of evapotranspiration, leaching of minerals, and ion exchange begin to modify the chemical composition of the water. The use and reuse of water for irrigation, addition of fertilizers, and water logging also may degrade the quality of ground water. The combined processes result in a general increase in concentration of nitrate and other dissolved ions.

Ground water in the San Luis Valley is used mainly for irrigation, domestic, and livestock supplies. The ground-water quality related to these uses is emphasized in this report. Chemical data for water samples collected in the unconfined and confined aquifers are shown in tables 2 and 3 (Supplemental Information section). Each well listed in the tables is located by township, range, and section (LOCAL IDENTIFIER), as explained in figure 9 (Supplemental Information section).

Table 1.--*Summary of chemical quality cause-and-effect relations*

[R. K. Glanzman, J. M. Dumeyer, and J. M. Klein, U.S. Geological Survey, written commun., 1970]

Cause	Principal effect on chemical quality
Natural:	
1. Leaching of soil and aquifer minerals by circulating water	Increase of concentration of dissolved solids.
2. Ion exchange	Increase in sodium.
3. Evapotranspiration from shallow water table	Increase in concentration of dissolved solids.
Artificial (manmade):	
1. Use and reuse of water for irrigation	Increase in concentration of dissolved salts.
2. Fertilizer application	Increase in concentration of nitrate and phosphate.
3. Waterlogging[1]	Increase in concentration of dissolved salts.

[1]Waterlogging refers to soils that have been supersaturated with water.

NITROGEN IN WATER FROM THE UNCONFINED AQUIFER

Concentrations of Dissolved Nitrite Plus Nitrate in Water from the Unconfined Aquifer Exceed the Drinking-Water Standard in Parts of the Valley

The standard for dissolved nitrate, expressed as nitrogen, is 10 milligrams per liter (U.S. Environmental Protection Agency, 1976, p. 81) and is based on possible health effects that may occur in infants drinking water containing more nitrate than the standard. A large intake of nitrates constitutes a hazard primarily to infants less than 3 months old and to the young of certain warm-blooded animals where conditions are favorable for nitrate reduction to nitrite in the gastrointestinal tract. When nitrite reaches the bloodstream, it reacts directly with hemoglobin to produce methemoglobin, which impairs oxygen transport. The differences in susceptibility to methemoglobinemia ("blue-baby disease") are not yet understood but seem to be related to a combination of factors including nitrate concentration, enteric bacteria, and the lower acidity characteristic of the digestive systems of baby mammals (U.S. Environmental Protection Agency, 1977, p. 107).

Nitrite plus nitrate concentrations exceeded the drinking-water standard in water sampled from wells completed in the unconfined aquifer near Center (fig. 3). The nitrite, nitrate, and nitrite plus nitrate concentrations are shown in table 2 (Supplemental Information section). The highest nitrite plus nitrate concentration, expressed as nitrogen, measured in this area was 33 milligrams per liter. According to the records of the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer, several domestic and stock wells in the Center area where ground water contains excessive nitrite plus nitrate concentrations are less than 100 feet deep. Water from any well less than 100 feet deep within this area needs to be tested for nitrite plus nitrate concentration before it is used as a source of drinking water for infants or young livestock.

Although water containing excessive nitrite plus nitrate concentration may not be suitable for some drinking-water supplies, excessive nitrite plus nitrate concentrations in the ground water used for irrigation can be beneficial to crops. When an acre-inch of water is applied to crops in the Center area, about 0.79 pound to more than 2.3 pounds of nitrogen are being applied, depending on the nitrogen concentration in the water contiguous to the irrigation well. The following equation converts milligrams per liter or parts per million of nitrate as nitrogen to pounds of nitrogen per acre-inch of water applied:

$$\text{milligrams per liter} \times 0.226 = \text{pounds of nitrogen per acre-inch of applied water.}$$

For example, if 20 inches of irrigation water containing 10 milligrams per liter of nitrate as nitrogen is applied to 1 acre of cropland, a total of 45 pounds of nitrogen has been applied. Therefore, using the available nitrogen in the ground water, less fertilizer would need to be applied to obtain the same crop yield. A reduction in fertilizer application also could help reduce the high nitrate concentrations in water in the unconfined aquifer.

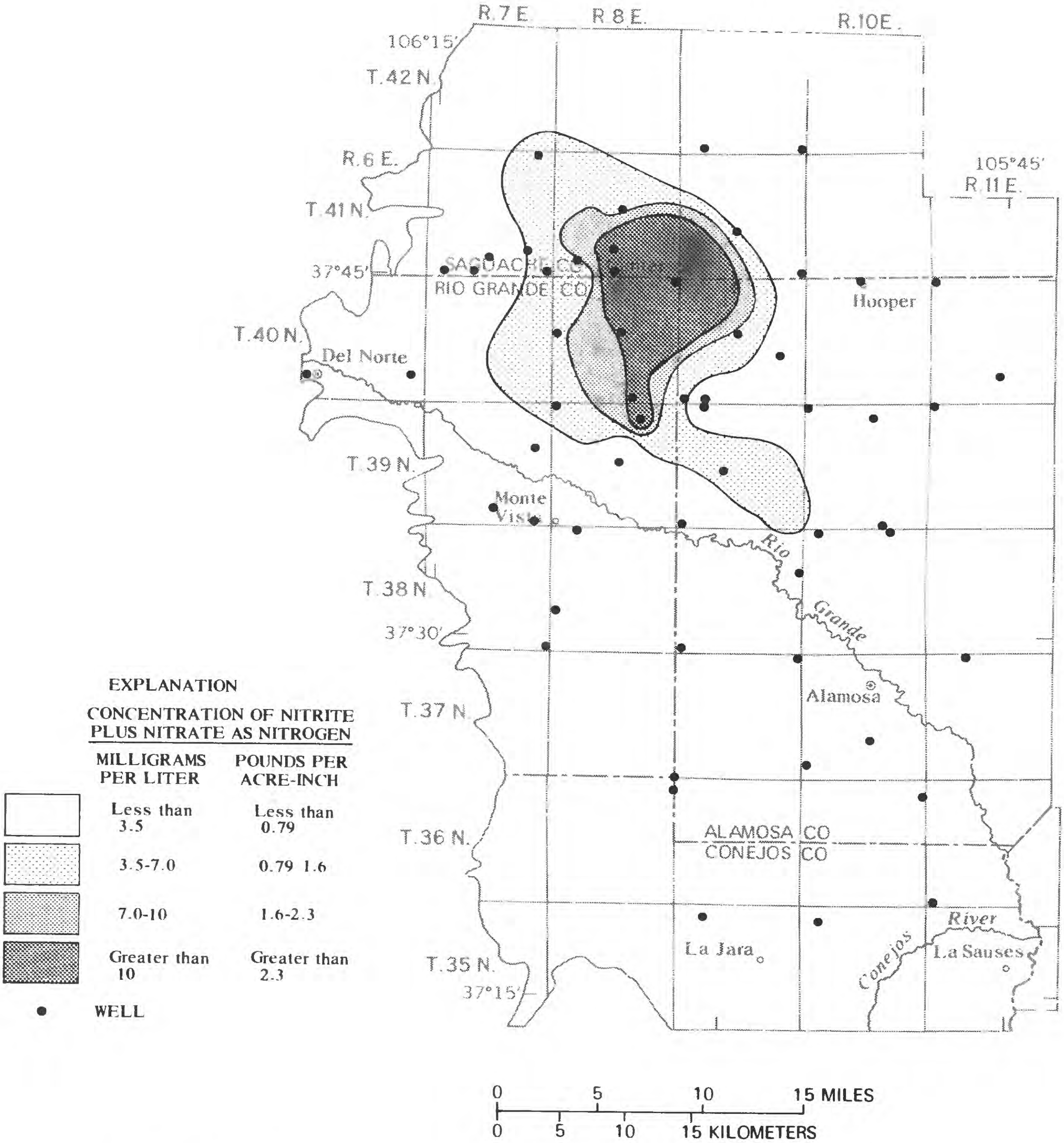

Figure 3.--Areal distribution of nitrite plus nitrate as nitrogen in water from the unconfined aquifer, July 1981.

NITROGEN IN WATER FROM THE UNCONFINED AQUIFER--Continued

Concentrations of Nitrite Plus Nitrate, As Nitrogen, Vary Vertically As Well As Areally in the Unconfined Aquifer

Nitrite plus nitrate concentrations, expressed as nitrogen, vary vertically as well as areally in the unconfined aquifer. Although insufficient data exist to determine the vertical location of the highest nitrogen concentrations in the unconfined aquifer, there is some evidence that vertical variation does occur in the valley. The vertical distribution of nitrite plus nitrate, as nitrogen, is illustrated in figure 4. The lower concentrations of nitrogen measured immediately above the uppermost confining layer may be a result of: (1) Upward leakage of water containing less nitrogen diluting the overlying concentrations of nitrogen, or (2) adsorption, which in turn results in the infiltration of nitrogen into the aquifer being slower than the downward movement of irrigation water, or (3) a combination of the two. The most significant fact is that a well drilled and completed in the upper part of the unconfined aquifer is likely to yield water having greater concentrations of nitrogen than a well completed at the base of the aquifer.

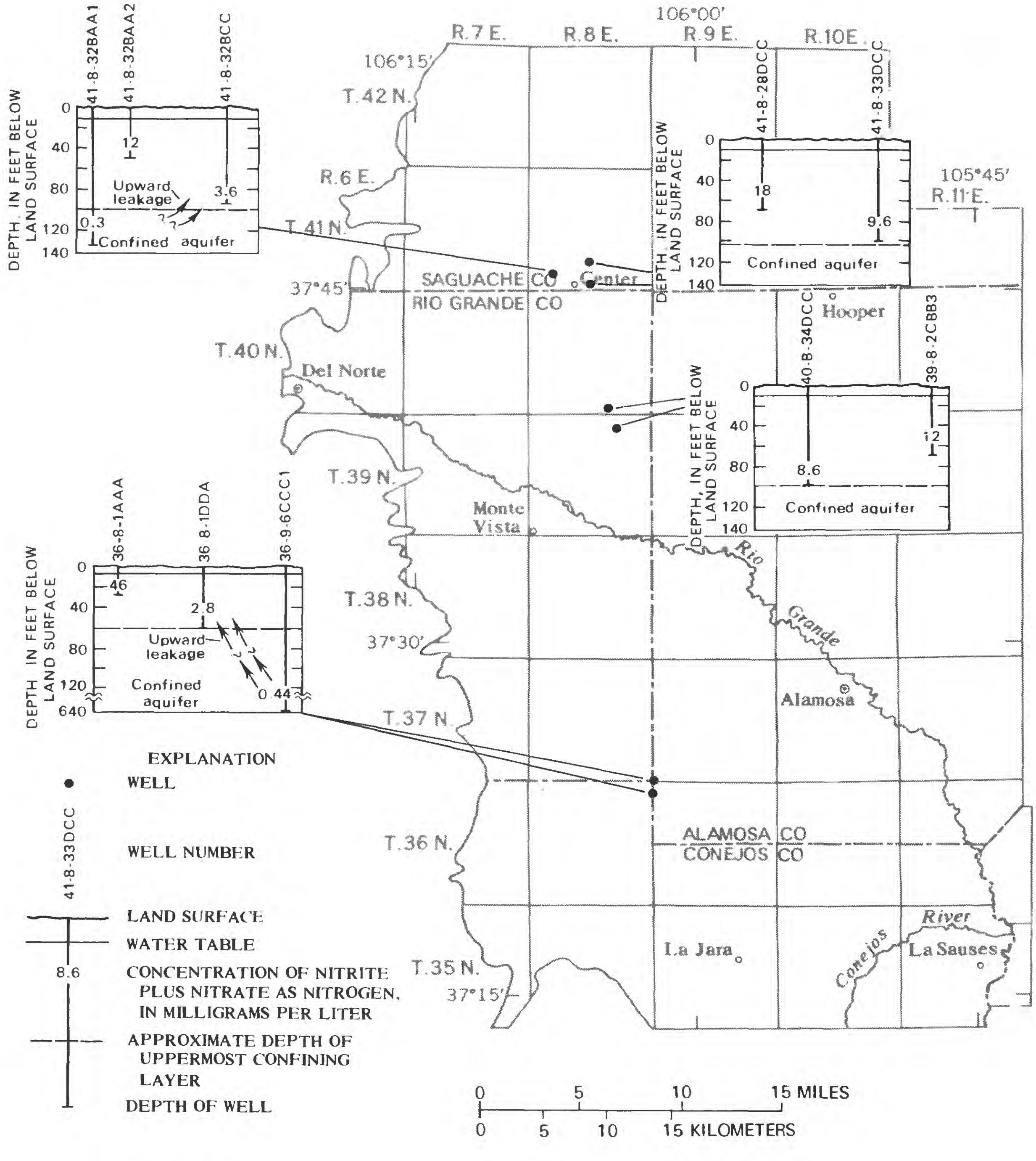

Figure 4.--Vertical distribution of nitrite plus nitrate as nitrogen in water from the unconfined aquifer, July 1981.

DISSOLVED SOLIDS IN WATER FROM THE UNCONFINED AQUIFER

Dissolved-Solids Concentration in Water from the Unconfined Aquifer May Decrease Crop Yields

Concentrations of dissolved solids greater than 500 milligrams per liter are objectionable because of possible physiological effects, mineral taste, and retardation of crop growth. Although waters with greater concentrations generally are not desirable for drinking, the U.S. Environmental Protection Agency (1977) recognizes that a considerable number of domestic water supplies with dissolved solids in excess of 500 milligrams per liter are used without any obvious physiological effects. Therefore, rather than emphasizing physiological effects, emphasis in this report generally is placed on decrease of crop yields resulting from high dissolved-solids concentrations.

The concentration of dissolved solids in water may be estimated by measuring the specific conductance of the water. The relationship of specific conductance to dissolved solids will vary depending on the distribution of the major ions present, but for any given water a relatively uniform relationship exists. Generally, a specific conductance of 750 micromhos per centimeter at 25° Celsius is approximately equivalent to 500 milligrams per liter of dissolved solids. Chemical analyses from the study area are shown in table 2 (Supplemental Information section). For those analyses for which dissolved-solids concentrations were not determined, the following equation may be used for approximating the dissolved-solids concentration from measurements of specific conductance:

Specific conductance x 0.67 = dissolved-solids concentration.

Salinity hazard is a relationship developed by the U.S. Salinity Laboratory (Richards, 1954) that describes the qualitative effect of saline waters on irrigated crops. It is based on the specific conductance of the water and is divided into four classes ranging from low to very high (fig. 5). Water with low salinity, specific conductance less than 250 μmho (micromhos per centimeter at 25° Celsius), and water with medium salinity, specific conductance between 250 to 750 μmho, can be used on plants having a moderate salt tolerance without special practices for salinity control. Of the main crops grown in the valley, potatoes, alfalfa, oats, and lettuce have moderate salt tolerance (Richards, 1954, p. 67). That is, a 10-percent reduction in crop yield will not occur until the specific conductance of the soil solution or the irrigation water exceeds 2,000 μmho. Barley and hay have a significant salt tolerance (Richards, 1954, p. 67). That is, a 10-percent reduction in crop yield will not occur until the specific conductance of the soil solution or the irrigation water exceeds 8,000 μmho. The specific conductance of the soil solution commonly is 2 to 10 times greater than the specific conductance of the applied irrigation water (Richards, 1954, p. 70).

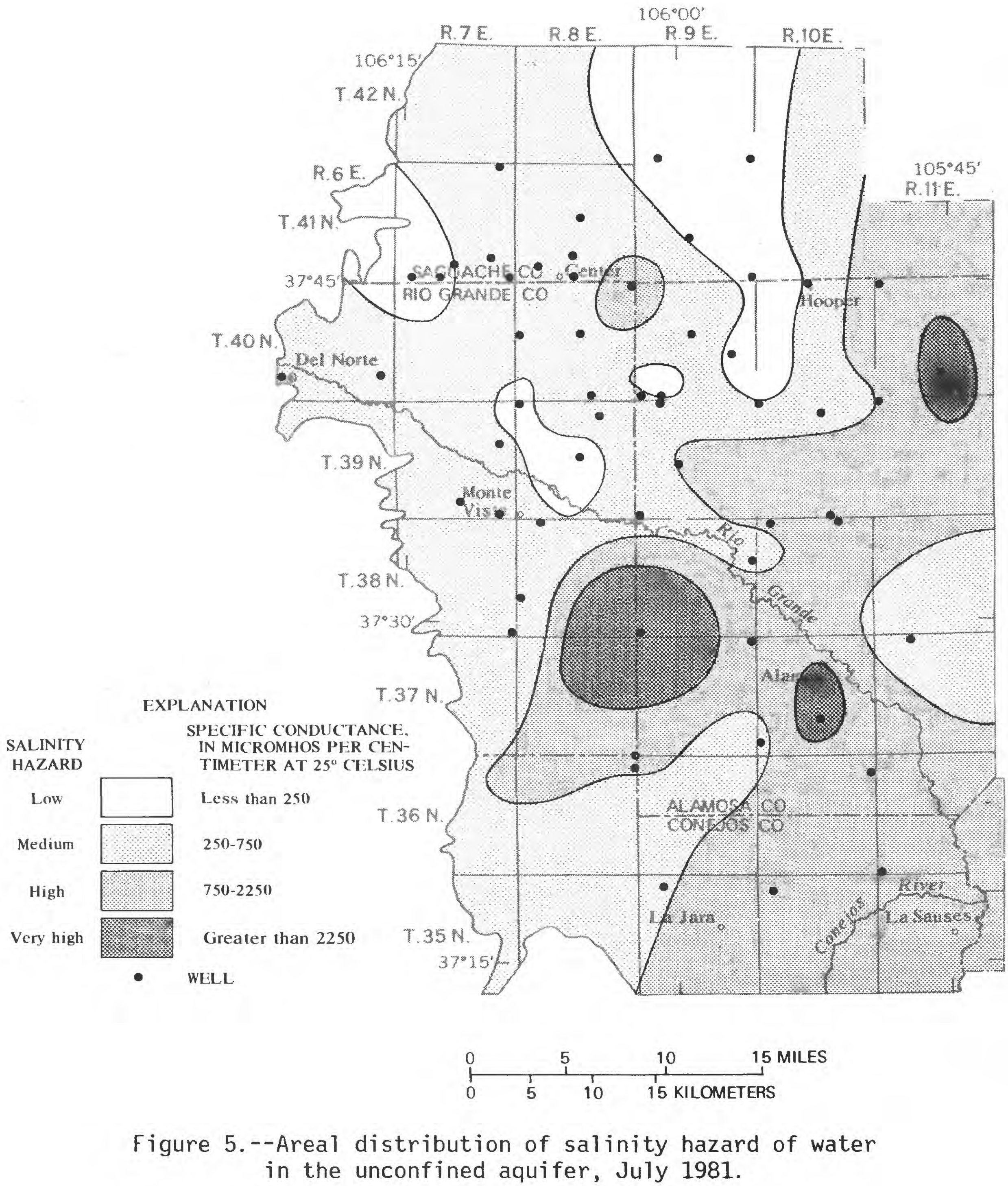

Figure 5.--Areal distribution of salinity hazard of water in the unconfined aquifer, July 1981.

DISSOLVED SOLIDS IN WATER FROM THE UNCONFINED AQUIFER--Continued

Water with high salinity has a specific conductance between 750 and 2,250 μmho. This water cannot be used on soil where drainage is restricted. Even with adequate drainage, special management for salinity control may be required and plants having a significant salt tolerance need to be selected.

Water with very high salinity has a specific conductance greater than 2,250 μmho. This water is not suitable for irrigation under ordinary conditions but may be used occasionally under special circumstances. The soil needs to be permeable, drainage needs to be adequate, irrigation water needs to be applied in excess to provide considerable leaching, and very salt-tolerant crops need to be selected.

Areas where water in the unconfined aquifer has either a high or a very high salinity hazard that could cause reductions in crop yield if care is not used in irrigation practices are shown in figure 5. Ground water having either a high or a very high salinity hazard appears to occur in those areas where evapotranspiration from a shallow water table and leaching of salts by recirculation of water applied for irrigation may be concurrently concentrating the dissolved solids.

SODIUM (ALKALI) HAZARD IN WATER FROM THE UNCONFINED AQUIFER

Sodium (Alkali) Hazard in the Unconfined Aquifer is Generally Low for Most of the Study Area

The sodium (alkali) hazard is a relationship developed by the U.S. Salinity Laboratory (Richards, 1954) which describes the qualitative effects of sodium or alkali on soil. The hazard is based on the sodium-adsorption ratio of water and is divided into four classes ranging from low to very high. Sodium-adsorption ratio may be derived by the following equation:

$$\text{sodium-adsorption ratio} = \text{sodium}/\sqrt{(\text{calcium} + \text{magnesium})/2}$$

Sodium-adsorption-ratio values are shown in table 2 (Supplemental Information section). The relative scale for sodium (alkali) hazard provides an index of the possibility of damage to soils caused by the concentration of sodium ions from irrigation water. The potential damage to a soil also depends on the properties of the soil. When exchangeable sodium in a soil exceeds 10 to 15 percent of the total cations on the exchange complex, soils containing clays generally will swell and become compacted. This decreases the movement of water and air to the plant roots and thereby decreases crop yields and eventually makes the soils unusable.

Water having a medium to high sodium (alkali) hazard should not be used on clayey soils or on soils strongly affected by alkali (fig. 6) without adequate drainage and some form of chemical amendment such as gypsum (Richards, 1954). Water having a very high sodium (alkali) hazard generally is considered to be unsatisfactory for irrigation. The areal distribution of sodium (alkali) hazard of water in the unconfined aquifer is shown in figure 6. Areas having a low sodium (alkali) hazard have calcium as the principal cation and are generally low in dissolved solids.

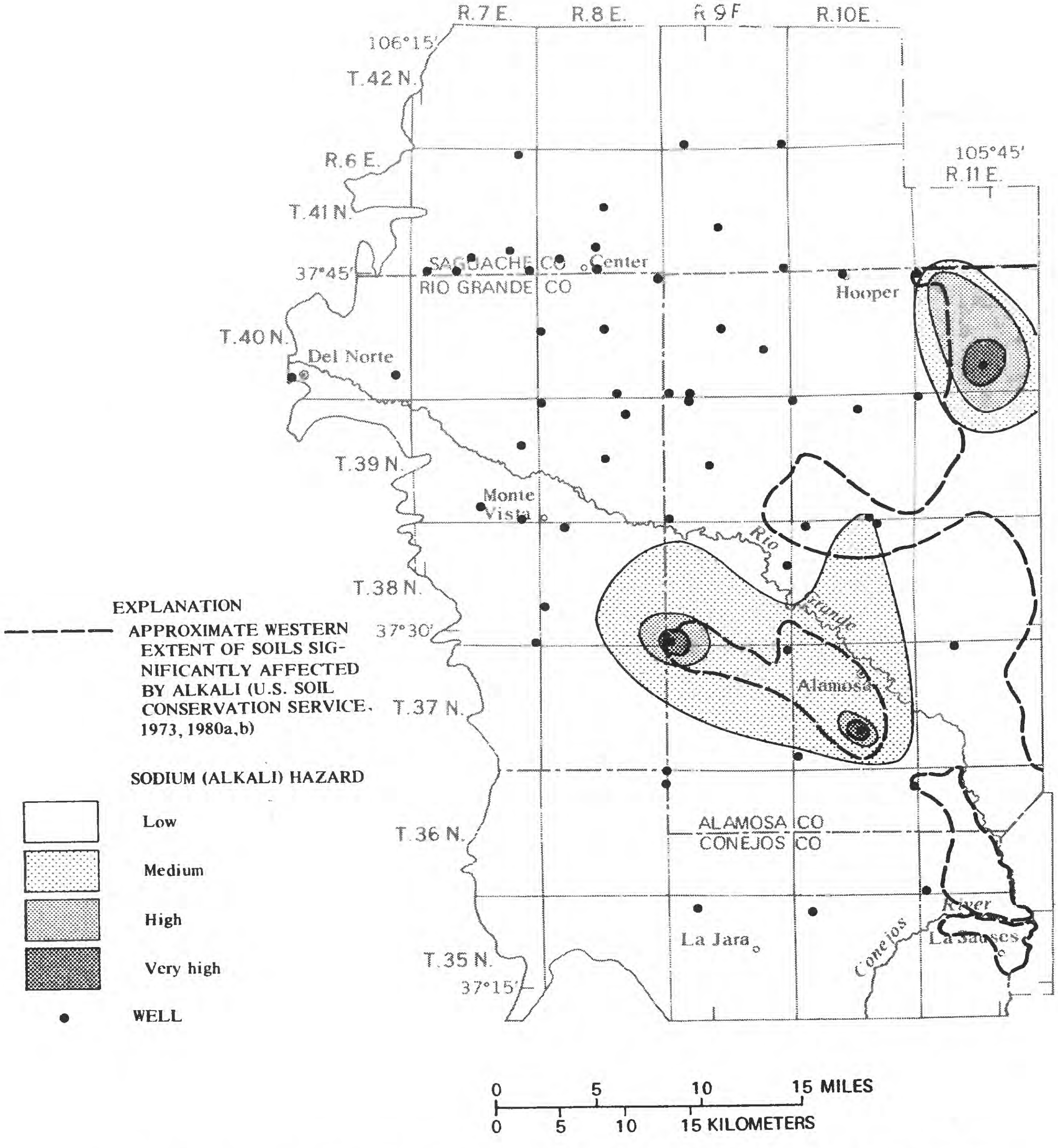

Figure 6.--Areal distribution of sodium (alkali) hazard of water in the unconfined aquifer, July 1981, and approximate extent of soils strongly affected by alkali.

QUALITY OF WATER IN THE CONFINED AQUIFER

Water in the Confined Aquifer Contains Less Dissolved Solids and Nitrogen than Water in the Unconfined Aquifer

Chemical data for water samples collected from 25 wells completed in the confined aquifer are shown in table 3 (Supplemental Information section). These data support the findings by Emery and others (1973, p. 20) that the quality of water from wells completed in the confined aquifer near the edge of the valley is suitable for most uses. Specific conductance, which provides a basis for estimating dissolved-solids concentration, generally is less than 250 micromhos per centimeter at 25° Celsius. The specific conductance of water in the confined aquifer near the valley perimeter probably reflects the quality of the recharge water. As water enters the confined aquifer and moves towards the center of the valley, the chemical composition of the confined water changes as a result of ion-exchange and dissolution of soluble valley-fill materials. Ion-exchange between the water and clay in the aquifer accounts for the decrease in calcium and the increase in sodium that occurs near the center of the study area (fig. 7). Dissolution of soluble valley-fill deposits accounts for the increase in dissolved solids. Other processes, such as evapotranspiration and leaching of salts by recirculating applied water, do not affect the quality of the water in the confined aquifer because the confined water generally is not in hydraulic connection with the land surface.

A comparison of the chemical composition and concentrations of dissolved solids in water from wells completed in the confined and unconfined aquifers illustrate the different hydrologic and chemical processes affecting their chemistry (figs. 5, 7). For example, the distribution of salinity in the confined aquifer is significantly different from that of the unconfined aquifer. The area having a low salinity hazard is substantially larger in the confined aquifer (fig. 7) than in the unconfined aquifer (fig. 5). This phenomenon probably occurs because evapotranspiration and leaching of salts by recirculation of applied water does not affect the water from wells completed in the confined aquifer; only dissolution of soluble valley-fill materials increases salinity in water from wells completed in the confined aquifer. The salinity is, therefore, concentrated near the center of the valley.

Water from wells completed in the confined aquifer contains concentrations of less than 1 milligram per liter of nitrite plus nitrate, as nitrogen. This occurs because water from wells completed in the confined aquifer is not in hydraulic connection with the land surface. Applied fertilizers and other potential surface sources of nitrogen, such as the effluent from septic tanks, do not move through the confining layer into the confined aquifer.

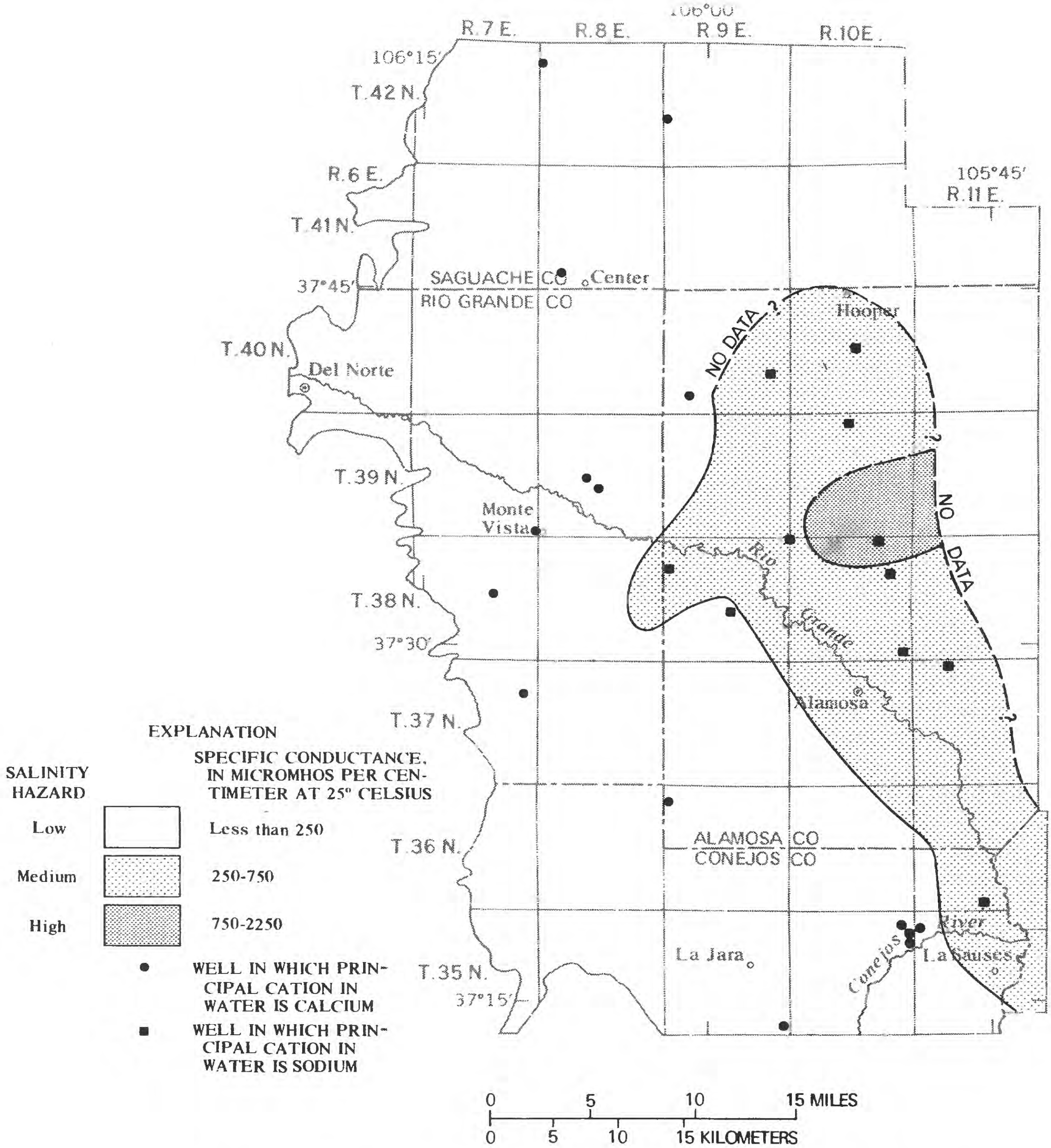

Figure 7.--Areal distribution of salinity hazard and principal cation in water from the confined aquifer, July 1981.

SHORT-AND LONG-TERM CHANGES IN THE QUALITY OF GROUND WATER

Significant Changes in Quality of Ground Water with Time Are Not Evident

A comparison of available historical and current data indicate that the dissolved-solids concentration of the ground water in the valley generally has not changed significantly. Variations in nitrogen and other dissolved-solids concentrations that have occurred at the same well site may not be a function of time but may be related to pumping practices, depth to water, depth of the well, depth to perforated interval of well, vertical variations of water quality within the aquifer, and variations in quality of recharge water (Schmidt, 1977; Nightingale and Bianchi, 1980).

Analyses of water samples collected from 24 wells completed in the unconfined aquifer in March and July 1981 were compared to evaluate potential seasonal variations in dissolved solids. Less than 10-percent change in specific conductance was measured in 15 wells (62 percent); specific conductance decreased at least 10 percent in 5 wells (21 percent) and increased at least 10 percent in 4 wells (17 percent). Similar results were obtained during the evaluation of the data for seasonal variations in nitrogen. Because there was no apparent trend in the data, seasonal variations in the ground-water quality were not determined.

Long-term (1968-81) changes in nitrite plus nitrate, as nitrogen concentrations, were not determined because different analytical methods were used in 1968-69 and 1981. The phenoldisulfonic acid method, which analyzes specifically for nitrate, as nitrate, was used in 1968-69 during the time Emery and others (1973) collected their data. In 1981, a colorimetric procedure that analyzed for nitrite plus nitrate as nitrogen was used. During the present study, seven water samples were analyzed using both methods in order to test for comparability of results. A regression analysis indicated the methods were not comparable.

Percent change in specific conductance was calculated using data for 11 samples collected from wells completed in the unconfined aquifer and 17 samples collected from wells completed in the confined aquifers sampled both in 1968-69 and in 1981 (fig. 8). The specific conductance of the water changed less than 10 percent in about 64 percent of the wells in the unconfined aquifer and in about 60 percent of the wells in the confined aquifer. Changes of specific conductance in water from the other wells were too variable and inconsistent to ascertain long-term trends.

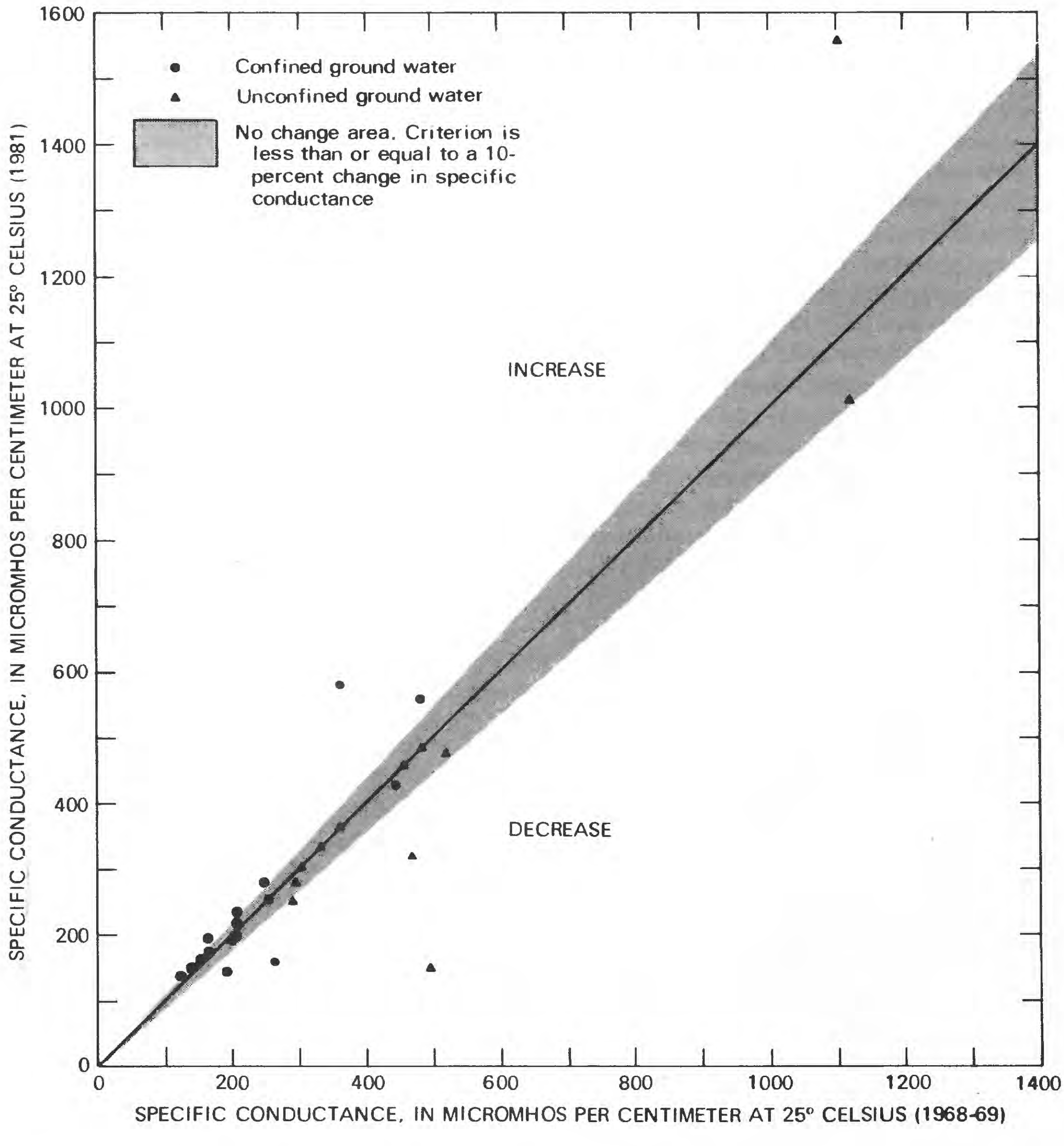

Figure 8.--Temporal change in specific conductance of water in the unconfined and confined aquifers from 1968-69 to 1981.

SUMMARY

The approximately 1,400-square-mile study area, which is located within the San Luis Valley, comprises an estimated 70 percent of the combined irrigated cropland in Saguache, Rio Grande, Alamosa, and Conejos Counties. Ground water in the study area occurs in unconfined and confined aquifers. Water in the aquifers moves towards the center of the valley and is used primarily for irrigation.

The chemical quality of ground water generally is suitable for domestic and agricultural uses without any detrimental effects. In most areas, the nitrite plus nitrate as nitrogen concentrations generally are less than 1 milligram per liter. However, the quality of water from wells completed in the unconfined aquifer in certain parts of the study area may pose potential health and agricultural hazards due to high concentrations of nitrate as nitrogen and high concentrations of dissolved solids resulting from recharge from irrigated fields.

Water from wells completed in the unconfined aquifer near Center contains concentrations of nitrite plus nitrate as nitrogen of as much as 33 milligrams per liter. Water containing more than 1 milligram per liter of nitrite as nitrogen, or 10 milligrams per liter of nitrate as nitrogen, poses a potential health hazard for infants less than 3 months old and should not be used as a source of their drinking-water supply. However, high concentrations of nitrite plus nitrate as nitrogen in ground water being used for irrigation could be beneficial to crops. If the available nitrogen in the ground water is used, less fertilizer would need to be applied for the same crop yield, resulting in a cost savings to the farmers. A reduction in fertilizer application also could help decrease the high nitrate concentrations in water from the unconfined aquifer.

Some of the water from wells completed in the unconfined aquifers in the study area contain high concentrations of dissolved solids. This water has a high to very high salinity hazard; without careful management practices crop yields may be reduced if this water is used for irrigation. The high salinity hazard in ground water seems to occur in those areas where evapotranspiration from a shallow water table and leaching of salts by recirculation of applied water may be concurrently concentrating the dissolved solids in the ground water. In certain parts of the area, the ground water having high dissolved-solids concentrations also contains a high percent of sodium resulting from ion exchange. The combination of a high percent of sodium in combination with relatively low concentrations of calcium and magnesium results in a high sodium (alkali) hazard. Without careful management practice a high sodium (alkali) hazard may reduce crop yields and eventually may render clayey soils or soils strongly affected by alkali unusable.

In general, no significant temporal trends in the quality of the unconfined water and the confined water were apparent.

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SUPPLEMENTAL INFORMATION

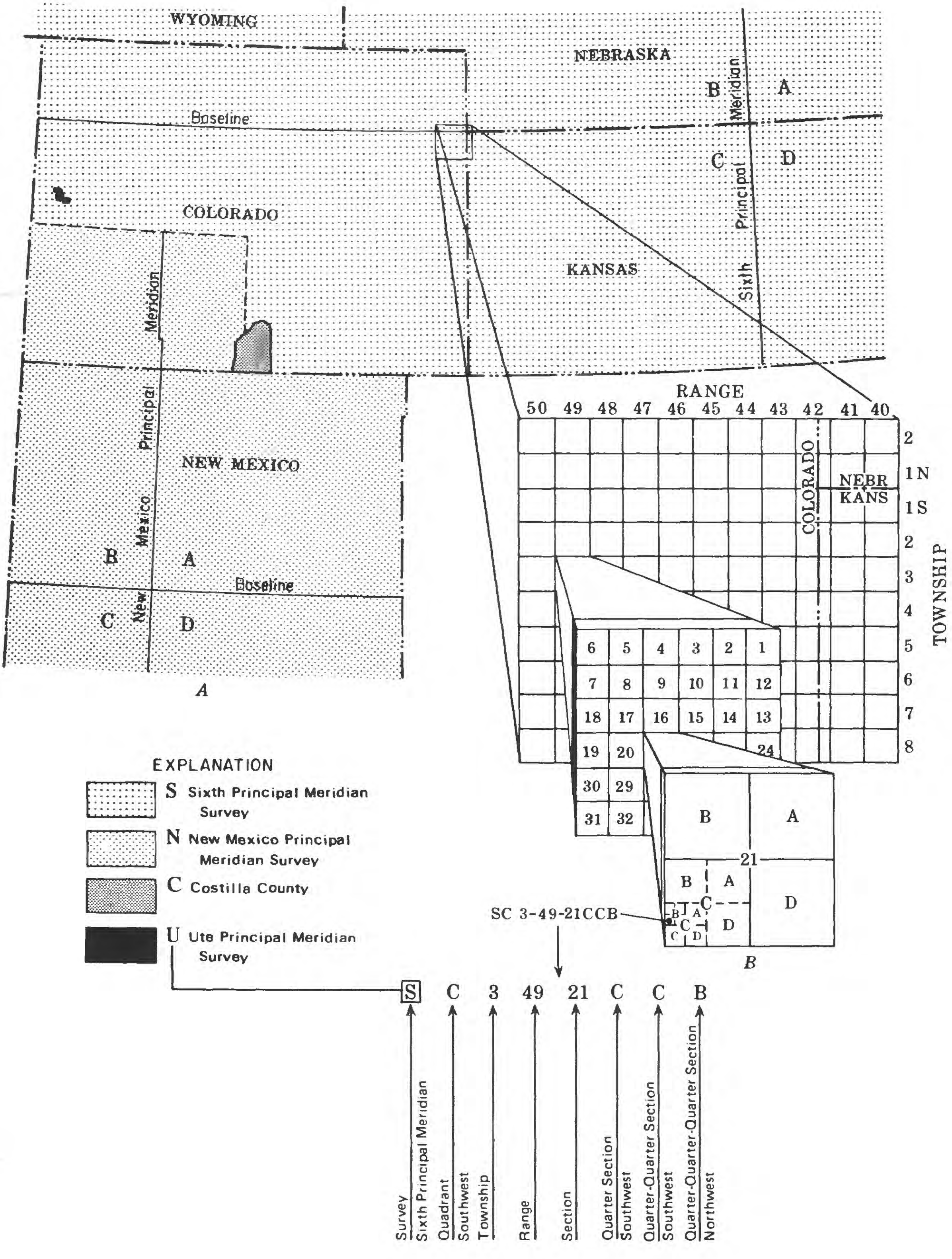

Figure 9.--System of numbering wells.

Table 2.--CHEMICAL ANALYSES OF WATER FROM WELLS COMPLETED IN THE UNCONFINED AQUIFER

[FT, feet; DEG C, degrees Celsius; UMHO, micromhos per centimeter at 25° Celsius; MG/L, milligrams per liter]

LOCAL IDENT-I-FIER	DATE OF SAMPLE	TIME	DEPTH BELOW LAND SURFACE (WATER LEVEL) (FT)	DEPTH OF WELL, TOTAL (FT)	TEMPER-ATURE (DEG C)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE LAB (UMHO)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
				ALAMOSA COUNTY						
NA03601001DAD	81-03-25	1045	9.40	30	8.5	7.1	1190	818	120	23
	81-07-14	1355	10.30	30	10.0	7.3	986	--	110	21
NA03700901AAA	81-03-24	1800	4.30	33	9.5	7.7	2060	1250	90	20
	81-07-14	1615	4.80	33	11.0	7.5	1860	--	65	18
NA03701027BBC	81-03-25	1240	2.80	26	10.0	8.2	2390	1730	22	5.2
	81-07-14	1450	2.90	26	12.0	8.1	3000	--	22	12
NA03701031BBB	81-03-25	1350	4.20	10	10.5	7.9	291	210	15	3.4
	81-07-14	1530	4.90	10	11.0	8.0	350	--	23	5.4
NA03701105AAA	81-03-25	0900	--	26	9.5	7.8	370	242	9.2	1.2
	81-07-14	1220	--	26	11.0	7.3	375	--	32	5.9
NA03800913AAA	81-07-23	1415	--	50	10.5	6.9	289	--	15	3.4
NA03800931CBC	81-03-24	1635	4.80	17	8.5	7.4	6480	4650	250	73
	81-07-15	1045	4.20	17	13.0	7.4	5520	--	150	62
NA03801002BBB2	81-07-21	1230	--	32	--	7.4	1710	--	150	31
NA03900921BAA1	81-03-25	0920	8.80	33	7.5	--	744	508	97	16
	81-07-14	1040	11.80	33	10.5	7.2	769	--	100	17
NA03900931CCB	81-03-25	1000	4.60	27	9.0	7.1	326	217	32	6.5
	81-07-14	1210	4.80	27	11.0	6.9	377	--	34	8.0
NA03901006BBB	81-03-25	1010	9.20	28	9.0	--	610	431	63	13
NA03901031CCC	81-03-24	1735	9.40	25	8.0	--	986	694	55	9.1
	81-07-14	1140	10.20	25	11.0	7.4	982	--	39	6.8
NA03901034DDD	81-03-24	1530	4.90	30	8.5	--	1190	890	24	4.4
	81-07-13	1010	4.90	30	12.5	7.9	1120	--	20	3.5
NA03901106BBB	81-03-25	1140	6.50	27	10.0	--	662	441	62	27
	81-07-13	1215	6.10	27	12.0	7.8	597	--	59	25
NA04000916DDD	81-03-25	1110	11.50	29	9.5	6.9	584	384	75	12
	81-07-23	1220	15.80	29	9.5	7.0	558	--	74	12
NA04000923DAA	81-07-21	1515	--	40	--	7.5	146	--	13	1.8
NA04000931CCC	81-03-25	1216	10.70	28	13.5	6.5	274	201	33	5.3
	81-07-14	0930	14.50	28	13.5	7.4	338	--	42	6.8
NA04000931CCC2	81-07-21	1050	--	84	11.0	7.1	313	--	38	5.4
NA04000932CBC	81-07-21	1130	--	45	--	7.9	155	--	19	1.2
NA04001004ACB	81-07-21	1430	--	100	17.0	7.2	230	--	9.4	1.9
NA04001106BBB	81-03-25	1220	3.40	20	8.5	--	932	591	55	17
	81-07-13	1310	5.00	20	12.5	7.5	920	--	54	17
				CONEJOS COUNTY						
NA03500905BBB	81-07-15	1530	3.50	28	12.0	7.9	712	507	84	21
NA03501006DDD	81-07-15	1400	4.20	35	8.5	7.3	1120	881	140	24
NA03600801AAA	81-03-25	1445	6.30	27	8.0	7.4	1340	1040	240	29
	81-07-15	1125	5.20	27	11.0	7.4	1300	--	210	25
NA03600801DDA	81-07-24	1045	--	60	--	7.6	362	--	46	6.0

Table 2.--CHEMICAL ANALYSES OF WATER FROM WELLS COMPLETED IN THE UNCONFINED AQUIFER--Continued

LOCAL IDENT- I FIER	DATE OF SAMPLE	SODIUM, DIS- SOLVED (MG/L AS NA)	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	SODIUM AD- SORP- TION RATIO	HARD- NESS (MG/L AS CACO3)	ALKA- LINITY LAB (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)
					ALAMOSA COUNTY					
NA03601001DAD	81-03-25	100	5.4	2.2	390	230	350	16	1.8	0.00
	81-07-14	99	5.4	2.3	360	--	--	--	--	1.4
NA03700901AAA	81-03-24	340	12	8.4	310	230	590	160	.5	.05
	81-07-14	310	11	8.8	240	--	--	--	--	.28
NA03701027BBC	81-03-25	540	6.4	26	80	710	340	160	3.3	.00
	81-07-14	800	9.1	34	100	--	--	--	--	.04
NA03701031BBB	81-03-25	41	2.5	2.5	51	94	40	1.9	.8	.01
	81-07-14	43	3.6	2.1	80	--	--	--	--	.06
NA03701105AAA	81-03-25	75	1.3	6.2	28	160	7.2	5.9	6.4	.00
	81-07-14	41	3.2	1.7	100	--	--	--	--	.07
NA03800913AAA	81-07-23	41	4.9	2.6	51	--	--	--	--	.09
NA03800931CBC	81-03-24	1300	19	19	930	1090	1540	760	.2	.12
	81-07-15	1100	20	19	630	--	--	--	--	.14
NA03801002BBB2	81-07-21	180	14	3.5	500	--	--	--	--	.17
NA03900921BAA1	81-03-25	32	9.7	.8	310	210	110	27	.1	4.5
	81-07-14	33	9.4	.8	320	--	--	--	--	4.5
NA03900931CCB	81-03-25	29	4.1	1.2	110	130	29	5.5	.4	.00
	81-07-14	31	4.4	1.2	120	--	--	--	--	.03
NA03901006BBB	81-03-25	38	7.9	1.1	210	150	52	20	.3	16
NA03901031CCC	81-03-24	160	9.8	5.3	170	280	210	10	.6	4.3
	81-07-14	160	9.0	6.2	130	--	--	--	--	4.5
NA03901034DDD	81-03-24	220	6.6	11	78	190	300	47	.6	.36
	81-07-13	230	9.5	12	64	--	--	--	--	.06
NA03901106BBB	81-03-25	33	8.8	.9	270	200	100	24	.2	.61
	81-07-13	29	8.7	.8	250	--	--	--	--	.50
NA04000916DDD	81-03-25	23	7.6	.7	240	180	63	13	.1	6.1
	81-07-23	20	8.2	.6	230	--	--	--	--	6.7
NA04000923DAA	81-07-21	11	6.3	.8	40	--	--	--	--	.05
NA04000931CCC	81-03-25	17	6.8	.7	100	110	14	2.4	.2	2.9
	81-07-14	15	7.0	.6	130	--	--	--	--	4.3
NA04000931CCC2	81-07-21	16	5.3	.6	120	--	--	--	--	5.0
NA04000932CBC	81-07-21	7.7	6.4	.5	52	--	--	--	--	.02
NA04001004ACB	81-07-21	38	5.5	3.0	31	--	--	--	--	.07
NA04001106BBB	81-03-25	120	9.7	3.6	210	320	110	44	.6	.00
	81-07-13	130	10	4.0	200	--	--	--	--	.09
					CONEJOS COUNTY					
NA03500905BBB	81-07-15	29	4.3	.7	300	--	--	--	--	.35
NA03501006DDD	81-07-15	76	7.4	1.6	450	--	--	--	--	.04
NA03600801AAA	81-03-25	37	6.8	.6	720	190	570	6.3	.7	17
	81-07-15	38	7.5	.7	630	--	--	--	--	46
NA03600801DDA	81-07-24	13	5.5	.5	140	--	--	--	--	2.8

Table 2.--CHEMICAL ANALYSES OF WATER FROM WELLS COMPLETED IN THE UNCONFINED AQUIFER--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	NITRO- GEN, NITRITE DIS- SOLVED (MG/L AS N)	NITRO- GEN, NITRATE DIS- SOLVED (MG/L AS N)	NITRO- GEN,AM- MONIA + ORGANIC DIS. (MG/L AS N)	NITRO- GEN, ORGANIC DIS- SOLVED (MG/L AS N)	NITRO- GEN, AMMONIA DIS- SOLVED (MG/L AS N)	NITRO- GEN DIS- SOLVED (MG/L AS N)	SILICA, DIS- SOLVED (MG/L AS SIO2)
			ALAMOSA COUNTY					
NA03601001DAD	81-03-25	0.000	0.00	0.41	0.41	0.000	0.41	43
	81-07-14	--	--	--	--	--	--	--
NA03700901AAA	81-03-24	.010	.04	.49	.42	.070	.54	29
	81-07-14	--	--	--	--	--	--	--
NA03701027BBC	81-03-25	.000	.00	.85	.77	.080	.85	42
	81-07-14	--	--	--	--	--	--	--
NA03701031BBB	81-03-25	.000	.01	.31	.25	.060	.32	47
	81-07-14	--	--	--	--	--	--	--
NA03701105AAA	81-03-25	.000	.00	.38	.38	.000	.38	34
	81-07-14	--	--	--	--	--	--	--
NA03800913AAA	81-07-23	--	--	--	--	--	--	--
NA03800931CBC	81-03-24	.010	.11	1.7	1.5	.210	1.8	42
	81-07-15	--	--	--	--	--	--	--
NA03801002BBB2	81-07-21	--	--	--	--	--	--	--
NA03900921BAA1	81-03-25	.020	4.50	2.5	2.5	.000	7.0	44
	81-07-14	--	--	--	--	--	--	--
NA03900931CCB	81-03-25	.000	.00	.51	.45	.060	.51	34
	81-07-14	--	--	--	--	--	--	--
NA03901006BBB	81-03-25	.030	16.0	1.1	1.1	.000	17	52
NA03901031CCC	81-03-24	.000	4.30	1.6	1.6	.000	5.9	46
	81-07-14	--	--	--	--	--	--	--
NA03901034DDD	81-03-24	.010	.35	.79	.65	.140	1.2	32
	81-07-13	--	--	--	--	--	--	--
NA03901106BBB	81-03-25	.010	.60	.85	.85	.000	1.5	48
	81-07-13	--	--	--	--	--	--	--
NA04000916DDD	81-03-25	.010	6.10	1.5	1.5	.000	7.6	41
	81-07-23	--	--	--	--	--	--	--
NA04000923DAA	81-07-21	--	--	--	--	--	--	--
NA04000931CCC	81-03-25	.000	2.90	.91	.91	.004	3.8	43
	81-07-14	--	--	--	--	--	--	--
NA04000931CCC2	81-07-21	--	--	--	--	--	--	--
NA04000932CBC	81-07-21	--	--	--	--	--	--	--
NA04001004ACB	81-07-21	--	--	--	--	--	--	--
NA04001106BBB	81-03-25	.000	.00	.49	.42	.074	.49	46
	81-07-13	--	--	--	--	--	--	--
			CONEJOS COUNTY					
NA03500905BBB	81-07-15	--	--	--	--	--	--	--
NA03501006DDD	81-07-15	--	--	--	--	--	--	--
NA03600801AAA	81-03-25	.000	17.0	1.3	1.2	.060	18	27
	81-07-15	--	--	--	--	--	--	--
NA03600801DDA	81-07-24	--	--	--	--	--	--	--

Table 2.--CHEMICAL ANALYSES OF WATER FROM WELLS COMPLETED IN THE UNCONFINED AQUIFER--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	TIME	DEPTH BELOW LAND SURFACE (WATER LEVEL) (FT)	DEPTH OF WELL, TOTAL (FT)	TEMPER-ATURE (DEG C)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE LAB (UMHO)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
				CONEJOS COUNTY						
NA03601131CCC	81-07-15	1235	5.70	30	14.0	7.1	920	635	98	16
				RIO GRANDE COUNTY						
NA03800736DDD	81-03-25	1400	8.10	55	12.0	7.7	267	155	31	7.3
NA03800805BBA	81-03-25	1245	10.20	31	11.0	7.0	266	187	30	4.9
	81-07-14	1330	7.40	31	12.0	6.9	259	—	28	4.7
NA03800830BCC	81-07-22	1330	—	90	--	6.5	277	—	37	8.0
NA03900713BBB2	81-07-22	1145	—	65	--	6.7	258	—	32	5.9
NA03900734BAB	81-07-22	1100	—	80	11.5	7.0	268	—	40	5.4
NA03900736CAB	81-07-02	1430	—	47	--	6.9	307	—	36	7.0
NA03900802CBB3	81-07-21	1450	—	70	11.0	7.2	467	—	56	8.2
NA03900806BCB	81-03-24	1315	24.90	37	11.0	7.3	323	215	38	5.9
	81-07-13	1040	31.40	37	15.0	7.3	224	—	26	4.7
NA03900815CDC	81-03-25	1115	6.70	32	10.5	7.2	301	212	35	5.5
	81-07-14	1110	5.40	32	11.5	7.1	144	—	15	2.5
NA04000625CBC	81-03-24	1030	29.50	48	10.5	6.9	438	268	73	7.2
	81-07-13	1230	27.20	48	10.0	7.3	447	—	72	7.7
NA04000630CAC	81-07-22	1010	—	250	--	6.1	452	—	48	10
NA04000701DAA	81-07-17	1550	—	100	--	7.7	314	—	38	5.7
NA04000801AAD	81-03-25	0900	4.70	25	8.0	7.7	900	623	100	21
	81-07-13	1530	7.40	25	10.0	7.7	947	—	100	21
NA04000815CCC	81-03-25	1432	14.40	77	10.5	6.5	450	293	56	8.1
NA04000818CBB2	81-07-17	1600	--	—	11.0	7.4	389	—	52	7.8
NA04000834DCC	81-07-21	1420	—	100	--	7.4	425	—	54	8.3
				SAGUACHE COUNTY						
NA04100701BAA	81-03-24	1430	7.50	30	9.0	—	275	199	28	7.1
	81-07-13	1400	6.20	30	9.5	6.8	273	—	27	7.1
NA04100726DCC1	81-07-17	1350	—	80	--	7.5	382	—	48	7.9
NA04100731DCC2	81-07-22	1510	—	92	--	7.7	153	—	17	2.4
NA04100733AAA	81-07-17	1415	—	65	--	7.5	243	—	28	4.2
NA04100733CCC	81-07-17	1450	—	100	--	7.4	232	—	29	4.3
NA04100736DDD	81-07-22	1055	—	100	15.0	7.3	285	—	35	5.8
NA04100815CCC4	81-03-25	1435	8.40	30	11.0	—	316	224	31	4.8
	81-07-13	1550	12.40	—	10.0	7.5	324	—	37	7.2
NA04100828DCC	81-07-22	1220	—	70	10.5	7.3	493	—	62	8.3
NA04100832BAA2	81-07-22	1155	—	50	11.0	7.3	352	—	39	4.7
NA04100832BCC	81-07-17	1235	—	95	11.0	7.0	196	—	21	3.0
NA04100833DCC	81-07-21	1300	--	102	11.0	7.3	463	—	59	8.4
NA04100921DAA	81-03-25	1610	6.20	32	11.0	7.4	159	129	15	2.4
	81-07-13	1700	6.30	32	11.0	7.5	166	—	16	2.4
NA04100936DDD	81-03-25	0950	12.90	27	7.5	7.9	922	597	12	1.4
NA04200931CCC2	81-03-25	1525	5.80	27	11.0	—	667	440	83	13
	81-07-13	1500	8.40	27	15.0	7.3	243	—	21	3.5

LOCAL IDENT- I- FIER	DATE OF SAMPLE	SODIUM, DIS- SOLVED (MG/L AS NA)	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	SODIUM AD- SORP- TION RATIO	HARD- NESS (MG/L AS CACO3)	ALKA- LINITY LAB (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)
CONEJOS COUNTY										
NA03601131CCC	81-07-15	72	4.9	1.8	310	--	--	--	--	0.70
RIO GRANDE COUNTY										
NA03800736DDD	81-03-25	12	3.7	.5	110	110	15	2.7	0.2	.47
NA03800805BBA	81-03-25	16	3.9	.7	95	98	24	3.8	.2	1.2
	81-07-14	16	4.1	.7	89	--	--	--	--	.85
NA03800830BCC	81-07-22	8.9	3.9	.3	130	--	--	--	--	.26
NA03900713BBB2	81-07-22	10	3.7	.4	100	--	--	--	--	2.2
NA03900734BAB	81-07-22	7.8	3.3	.3	120	--	--	--	--	.52
NA03900736CAB	81-07-02	14	6.6	.6	120	--	--	--	--	1.6
NA03900802CBB3	81-07-21	24	6.0	.8	170	--	--	--	--	12
NA03900806BCB	81-03-24	15	5.0	.6	120	92	29	3.1	.3	7.2
	81-07-13	7.9	4.6	.4	84	--	--	--	--	4.4
NA03900815CDC	81-03-25	15	3.8	.6	110	88	34	3.0	.6	5.4
	81-07-14	9.6	2.8	.6	48	--	--	--	--	.61
NA04000625CBC	81-03-24	7.8	5.6	.2	210	210	6.4	.8	.2	1.9
	81-07-13	9.1	5.4	.3	210	--	--	--	--	1.8
NA04000630CAC	81-07-22	30	3.7	1.0	160	--	--	--	--	1.6
NA04000701DAA	81-07-17	17	3.9	.7	120	--	--	--	--	3.8
NA04000801AAD	81-03-25	49	13	1.2	340	210	140	10	.2	28
	81-07-13	56	16	1.3	340	--	--	--	--	33
NA04000815CCC	81-03-25	19	6.4	.6	170	130	35	2.9	.2	11
NA04000818CBB2	81-07-17	17	4.7	.6	160	--	--	--	--	6.9
NA04000834DCC	81-07-21	18	5.8	.6	170	--	--	--	--	8.6
SAGUACHE COUNTY										
NA04100701BAA	81-03-24	13	2.9	.6	99	84	27	4.1	.2	3.8
	81-07-13	15	3.1	.7	97	--	--	--	--	3.8
NA04100726DCC1	81-07-17	20	3.9	.7	150	--	--	--	--	2.7
NA04100731DCC2	81-07-22	9.1	2.4	.5	52	--	--	--	--	.57
NA04100733AAA	81-07-17	14	2.7	.7	87	--	--	--	--	3.7
NA04100733CCC	81-07-17	11	2.5	.5	90	--	--	--	--	.92
NA04100736DDD	81-07-22	15	4.6	.6	110	--	--	--	--	5.7
NA04100815CCC4	81-03-25	24	4.7	1.1	97	100	32	2.8	.3	3.8
	81-07-13	21	5.1	.8	120	--	--	--	--	6.0
NA04100828DCC	81-07-22	25	6.3	.8	190	--	--	--	--	13
NA04100832BAA2	81-07-22	24	6.3	1.0	120	--	--	--	--	12
NA04100832BCC	81-07-17	12	3.1	.6	65	--	--	--	--	3.6
NA04100833DCC	81-07-21	22	6.0	.7	180	--	--	--	--	9.6
NA04100921DAA	81-03-25	14	3.9	.9	47	62	14	1.3	.3	.34
	81-07-13	15	3.8	.9	50	--	--	--	--	.24
NA04100936DDD	81-03-25	210	3.1	15	36	480	1.4	2.9	2.9	.39
NA04200931CCC2	81-03-25	34	6.8	.9	260	220	78	17	.2	5.6
	81-07-13	26	4.3	1.4	67	--	--	--	--	.57

Table 2.--CHEMICAL ANALYSES OF WATER FROM WELLS COMPLETED IN THE UNCONFINED AQUIFER--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	NITRO- GEN, NITRITE DIS- SOLVED (MG/L AS N)	NITRO- GEN, NITRATE DIS- SOLVED (MG/L AS N)	NITRO- GEN,AM- MONIA + ORGANIC DIS. (MG/L AS N)	NITRO- GEN, ORGANIC DIS- SOLVED (MG/L AS N)	NITRO- GEN, AMMONIA DIS- SOLVED (MG/L AS N)	NITRO- GEN DIS- SOLVED (MG/L AS N)	SILICA, DIS- SOLVED (MG/L AS SIO2)
				CONEJOS COUNTY				
NA03601131CCC	81-07-15	--	--	--	--	--	--	--
				RIO GRANDE COUNTY				
NA03800736DDD	81-03-25	0.070	0.40	0.41	0.41	0.000	0.88	14
NA03800805BBA	81-03-25	.000	1.20	.80	.80	.000	2.0	39
	81-07-14	--	--	--	--	--	--	--
NA03800830BCC	81-07-22	--	--	--	--	--	--	--
NA03900713BBB2	81-07-22	--	--	--	--	--	--	--
NA03900734BAB	81-07-22	--	--	--	--	--	--	--
NA03900736CAB	81-07-02	--	--	--	--	--	--	--
NA03900802CBB3	81-07-21	--	--	--	--	--	--	--
NA03900806BCB	81-03-24	.000	7.20	1.1	1.1	.000	8.3	30
	81-07-13	--	--	--	--	--	--	--
NA03900815CDC	81-03-25	.010	5.40	1.5	1.5	.050	6.9	41
	81-07-14	--	--	--	--	--	--	--
NA04000625CBC	81-03-24	.010	1.90	.85	.78	.070	2.8	33
	81-07-13	--	--	--	--	--	--	--
NA04000630CAC	81-07-22	--	--	--	--	--	--	--
NA04000701DAA	81-07-17	--	--	--	--	--	--	--
NA04000801AAD	81-03-25	.000	28.0	.90	.90	.000	29	39
	81-07-13	--	--	--	--	--	--	--
NA04000815CCC	81-03-25	.000	11.0	1.7	1.7	.000	13	33
NA04000818CBB2	81-07-17	--	--	--	--	--	--	--
NA04000834DCC	81-07-21	--	--	--	--	--	--	--
				SAGUACHE COUNTY				
NA04100701BAA	81-03-24	.000	3.80	.98	.98	.000	4.8	41
	81-07-13	--	--	--	--	--	--	--
NA04100726DCC1	81-07-17	--	--	--	--	--	--	--
NA04100731DCC2	81-07-22	--	--	--	--	--	--	--
NA04100733AAA	81-07-17	--	--	--	--	--	--	--
NA04100733CCC	81-07-17	--	--	--	--	--	--	--
NA04100736DDD	81-07-22	--	--	--	--	--	--	--
NA04100815CCC4	81-03-25	.000	3.80	.87	.87	.000	4.7	36
	81-07-13	--	--	--	--	--	--	--
NA04100828DCC	81-07-22	--	--	--	--	--	--	--
NA04100832BAA2	81-07-22	--	--	--	--	--	--	--
NA04100832BCC	81-07-17	--	--	--	--	--	--	--
NA04100833DCC	81-07-21	--	--	--	--	--	--	--
NA04100921DAA	81-03-25	.010	.33	.34	.29	.050	.68	40
	81-07-13	--	--	--	--	--	--	--
NA04100936DDD	81-03-25	.000	.39	1.5	1.5	.000	1.9	46
NA04200931CCC2	81-03-25	.000	5.60	.71	.71	.000	6.3	34
	81-07-13	--	--	--	--	--	--	--

LOCAL IDENT-I-FIER	DATE OF SAMPLE	TIME	DEPTH BELOW LAND SURFACE (WATER LEVEL) (FT)	DEPTH OF WELL, TOTAL (FT)	TEMPER-ATURE (DEG C)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE LAB (UMHO)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
				SAGUACHE COUNTY						
NA04200936DDD	81-03-25	1545	9.70	24	10.0	7.3	1180	768	83	14

LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM, DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	SODIUM AD-SORP-TION RATIO	HARD-NESS (MG/L AS CACO3)	ALKA-LINITY LAB (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)
NA04200936DDD	81-03-25	160	11	4.3	270	330	210	50	0.3	1.1

LOCAL IDENT-I-FIER	DATE OF SAMPLE	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N)	NITRO-GEN, NITRATE DIS-SOLVED (MG/L AS N)	NITRO-GEN,AM-MONIA + ORGANIC DIS. (MG/L AS N)	NITRO-GEN, ORGANIC DIS-SOLVED (MG/L AS N)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N)	NITRO-GEN DIS-SOLVED (MG/L AS N)	SILICA, DIS-SOLVED (MG/L AS SIO2)
NA04200936DDD	81-03-25	0.000	1.10	1.0	1.0	0.000	2.1	40.

Table 3.--CHEMICAL ANALYSES OF WATER FROM WELLS COMPLETED IN THE CONFINED AQUIFER

[FT, feet; DEG C, degrees Celsius; UMHO, micromhos per centimeter at 25° Celsius; MG/L, milligrams per liter]

LOCAL IDENT-I-FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FT)	TEMPER-ATURE (DEG C)	PH (UNITS)	SPE-CIFIC CON-DUCT-ANCE LAB (UMHO)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)
				ALAMOSA COUNTY						
NA03600906CCC1	81-07-24	1315	642	15.[illegible]	7.8	219	0.44	28	2.9	6.9
NA03701105AAA	81-07-21	1000	875	17.0	7.4	363	.02	8.5	.7	74
NA03800901ADA	81-07-21	1525	--	22.3	7.5	561	.14	6.5	1.8	130
NA03800907CCC	81-07-21	1315	200	13.5	7.5	305	.02	5.1	.8	64
NA03800922CBC	81-07-22	0945	1840	27.5	7.4	179	.18	4.9	.4	32
NA03801002BBB1	81-07-21	1215	100	12.0	7.4	1710	.19	140	31	170
NA03801011DCC	81-07-21	1140	--	21.0	7.5	551	.03	6.2	.6	130
NA03801036CCC	81-07-21	1100	--	--	7.4	255	.03	6.2	.7	56
NA03901004DDB	81-07-21	1315	100	--	7.2	297	.30	13	2.8	47
NA04000925BBA	81-07-21	1535	--	16.5	6.2	459	.03	2.9	.1	100
NA04000932BBC	81-07-21	1210	--	--	8.0	157	.07	20	1.0	7.3
NA04001022BBB	81-07-21	1345	2063	32.0	7.7	443	.02	3.1	.2	110
				CONEJOS COUNTY						
NA03500936CCC	81-07-17	1145	433	15.0	--	149	.35	17	3.1	7.7
NA03501001CCC	81-08-11	1400	708	17.5	--	203	.21	25	2.8	10
NA03501012BBC	81-07-16	1145	700	16.0	--	185	.27	22	2.4	7.9
NA03501013CCB	81-07-16	1440	335	17.0	--	162	.31	15	2.9	12
NA03501107BBA	81-08-11	1315	335	16.0	--	229	.22	23	3.4	12
NA03601134CCC	81-08-11	1215	318	25.0	--	286	.01	8.4	.6	55
				RIO GRANDE COUNTY						
NA03700712CBC2	81-07-24	1130	65	--	7.0	219	.35	20	3.7	18
NA03800715DBC	81-07-22	1245	750	--	7.2	182	.91	24	3.3	7.5
NA03900821BBB	81-07-21	1530	235	--	7.7	142	.03	17	2.2	5.4
NA03900821DDA	81-07-21	1530	986	13.[illegible]	8.0	125	.18	18	.8	6.3
NA03900736DDD	81-07-22	142[illegible]	--	--	7.[illegible]	[illegible]	.65	[illegible]	2.2	5.3
				SAGUACHE COUNTY						
NA04100832BAA1	81-07-22	113[illegible]	--	--	7.5	147	.39	18	2.8	5.6
NA04200919CCC	81-07-22	1330	2300	--	8.0	155	.07	12	.6	17

Table 3.--CHEMICAL ANALYSES OF WATER FROM WELLS COMPLETED IN THE CONFINED AQUIFER--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	SODIUM AD- SORP- TION RATIO	HARD- NESS (MG/L AS CACO3)
	ALAMOSA COUNTY			
NA03600906CCC1	81-07-24	4.3	0.3	82
NA03701105AAA	81-07-21	1.3	6.6	24
NA03800901ADA	81-07-21	3.8	12	24
NA03800907CCC	81-07-21	3.4	7.0	16
NA03800922CBC	81-07-22	4.0	3.8	14
NA03801002BBB1	81-07-21	14	3.4	480
NA03801011DCC	81-07-21	3.7	13	18
NA03801036CCC	81-07-21	2.4	5.7	18
NA03901004DDB	81-07-21	5.0	3.1	44
NA04000925BBA	81-07-21	3.6	16	8
NA04000932BBC	81-07-21	5.9	.4	54
NA04001022BBB	81-07-21	2.4	16	9
	CONEJOS COUNTY			
NA03500936CCC	81-07-17	2.5	.5	55
NA03501001CCC	81-08-11	5.8	.5	74
NA03501012BBC	81-07-16	4.4	.4	65
NA03501013CCB	81-07-16	3.2	.7	49
NA03501107BBA	81-08-11	6.8	.6	71
NA03601134CCC	81-08-11	7.9	5.0	23
	RIO GRANDE COUNTY			
NA03700712CBC2	81-07-24	4.2	1.0	65
NA03800715DBC	81-07-22	3.0	.4	74
NA03900821BBB	81-07-21	5.1	.3	52
NA03900821DDA	81-07-21	2.1	.4	48
NA03900736DDD	81-07-22	3.0	.4	54
	SAGUACHE COUNTY			
NA04100832BAA1	81-07-22	4.4	.3	56
NA04200919CCC	81-07-22	5.9	1.3	32