SHALLOW GROUND-WATER CONDITIONS, TOM GREEN COUNTY, TEXAS

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DEPARTMENT OF THE INTERIOR

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METRIC CONVERSIONS

The inch-pound units of measurements used in this report may be converted to metric (International System) units by using the following conversion factors:

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
acre-foot (acre-ft)	0.001233	cubic hectometer
square mile (mi^2)	2.590	square kilometer
foot per mile (ft/mi)	0.189	meter per kilometer
gallon per minute (gal/min)	0.06308	liter per second
	0.003785	cubic meter per minute
degree Fahrenheit (°F)	5/9(°F - 32)	degree Celsius (°C)

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TOM GREEN COUNTY, TEXAS

By

J. N. Lee

ABSTRACT

Most of the water needs of Tom Green County, Texas, are supplied by ground water; however, the city of San Angelo is supplied by surface water. Ground-water withdrawals during 1980 (latest year for which data are available) in Tom Green County totaled about 15,300 acre-feet, all derived from shallow aquifers. Shallow aquifers in this report refer to the ground-water system generally less than 400 feet deep that contains water with less than a 10,000 milligrams per liter concentration of dissolved solids; aquifers comprising this system include: The Leona, Comanche Peak, Trinity, Blaine, San Angelo, Choza, Bullwagon, Vale, Standpipe, and Arroyo aquifers.

The current (1983) water levels in shallow aquifers in Tom Green County are relatively unchanged from those levels listed in previous reports. In most wells, the change in water level is less than 10 feet, and only a few isolated wells or areas have changes of more than 20 feet. Based on long-term hydrographs of selected wells and precipitation, water levels are directly related to precipitation and associated pumpage for irrigation. Current (1983) water levels probably are higher than normal due to the above-normal precipitation during 1980-81.

Ground water in Tom Green County commonly is very hard (greater than 180 milligrams per liter as calcium carbonate), and chemical types vary in the aquifers and in different parts of the county. The concentrations of dissolved solids range from 200 to 3,000 milligrams per liter, the dissolved-chloride concentrations range from about 40 to 1,000 milligrams per liter, and the dissolved-sulfate concentrations normally range from about 25 to 600 milligrams per liter. The dissolved-nitrate concentrations in samples from eight wells ranged from 2 to 37 milligrams per liter. Five of these samples exceeded the maximum contaminant level of 10 milligrams per liter set by the U.S. Environmental Protection Agency. Of the eight water samples analyzed for minor elements, two exceeded the maximum contaminant level for selenium, and one exceeded the maximum contaminant level for manganese. Samples from three wells were analyzed for selected pesticides; no pesticides were detected.

Two groups of ground-water samples were tested for bacteria in April and August 1983. The first group consisted of samples from 25 wells; no samples contained fecal-coliform bacteria, but 15 samples contained fecal-streptococci bacteria. The second group consisted of samples from 29 wells and 1 spring; twelve of these samples contained fecal-coliform bacteria and all 30 contained

fecal-streptococci bacteria. Water samples from seven wells were common to both groups, and the samples tested in August contained more bacteria. Counts of fecal-coliform bacteria ranged from 0 to 26 colonies per 100 milliliters with most less than 5 colonies per 100 milliliters. Counts of fecal-streptococci bacteria ranged from 0 to 400 colonies per 100 milliliters with most less than 20 colonies per 100 milliliters. The presence of fecal-coliform and fecal-streptococci bacteria in water is only an indicator that pollution from septic systems may be present and is not a positive check for fecal pollution. Generally, the aquifers are not contaminated by septic-system effluent, however, some individual wells or localized areas could be contaminated by nearby septic systems.

Using dissolved-solids concentrations as an indicator, historical and current (1983) water-quality records were compared to determine if any changes in water quality had occurred. The quality of water from Cretaceous rocks underlying the Edwards Pleateau has not changed significantly; this water is the least mineralized ground water in the county. The quality of water from the Arroyo and Bullwagon aquifers in the eastern most part of the county also has not changed significantly; dissolved-solids concentrations range from 1,500 to 2,000 milligrams per liter. In the remainder of the county, dissolved-solids concentrations have increased from 10 to 500 milligrams per liter in ground water along the river valleys and in the Lipan Flat area and increases of 500 to 1,100 milligrams per liter have occurred in ground water southeast of San Angelo, west of Twin Buttes Reservoir, and about 10 miles east of San Angelo. Locally, dissolved-solids concentrations have increased by as much as 4,530 milligrams per liter in water from individual wells.

Pollution from oil-field activities may affect the quality of water in some isolated wells and in some areas in the county. No historical records are available for determining any changes in pesticides, minor elements, or bacteria.

INTRODUCTION

In Tom Green County, Texas, ground water is most readily available in the alluvial valley of the Concho River east of the city of San Angelo (fig. 1). In the other areas of the county, ground water generally is limited in quantity, and its quality may vary from fresh to saline. The total area of Tom Green County is 1,547 mi^2. About 300 mi^2 is cropland of which about 22 mi^2 is irrigated, and about 1,100 mi^2 is rangeland. Major economic bases of the county are agriculture (sheep, cattle, grain sorghum, cotton, and dairy products), Goodfellow Air Force Base, oil and gas production, manufacturing, and San Angelo State University. The population of the county in 1980 was 84,780 (U.S. Bureau of the Census, 1980) of which 73,240 were residents of San Angelo, the county seat.

Demands on the ground-water resources of Tom Green County are expected to continue to increase, and concerns have been expressed regarding the future availability of water and the possible deterioration of the quality of water in the shallow aquifer system. Documentation of existing ground-water conditions for subsequent planning is needed for development, management, and utilization

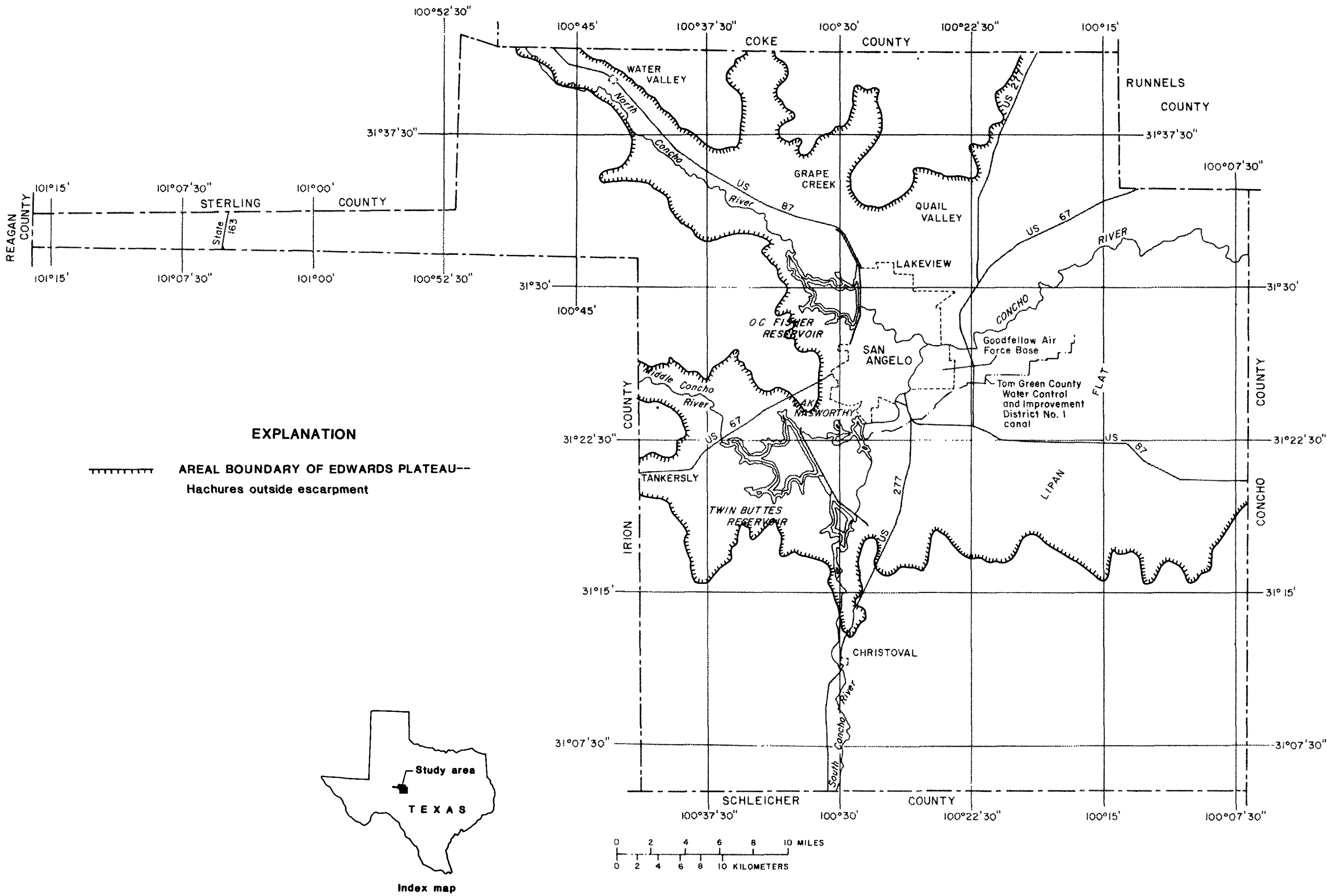

Figure 1.--Location of study area.

of the water resources by individuals, commercial establishments, and govenment agencies. At the request of, and in cooperation with Tom Green County and the city of San Angelo, the U.S. Geological Survey began a study in 1982 with three major objectives:

1. To define the current (1983) altitude of the water table and the water-quality characteristics of the shallow aquifer system.
2. To determine the historical changes, if possible, in water levels and water-quality characteristics.
3. To identify, where possible, the causes of any detected changes in water levels and water-quality characteristics.

Purpose and Scope

This report presents results of a 3-year, county-wide study to describe the present (1983) characteristics of the shallow aquifer system and the historical changes in these characteristics. Discussion is limited to aquifers that generally are less than 400 ft deep and that contain water with less than 10,000 mg/L (milligrams per liter) dissolved solids. Emphasis was placed on determining current (1983) ground-water levels and water-quality characteristics, as indicated by dissolved-solids concentrations, and on historical changes in these conditions. Attention was given to water-quality characteristics that included major inorganic constituents, minor and trace elements, bacteria, and pesticides. Much of the water-level and water-quality data included in this report were collected from 1967 to 1982 by the Texas Department of Water Resources (currently the Texas Water Commission) and its preceding agencies. A driller's-log file maintained by the Texas Department of Water Resources was helpful in the inventory of recent wells.

Previous Studies

An inventory of wells and springs in Tom Green County was made during 1940-41. These data, including laboratory analyses of water samples, were published by the Texas Board of Water Engineers in September 1941. The study was a project of the Work Projects Administration (1941) in cooperation with the Texas Board of Water Engineers and was under the technical supervision of the U.S. Geological Survey.

The ground-water resources of Tom Green County were first described by Willis (1954). This report contains data from well inventories, water levels, quality of water, and aquifer determinations. Mount and others (1967) described the ground-water resources of the Colorado River basin in general terms; and well data, pumpage, water levels, geology, and aquifer information for Tom Green County are briefly mentioned.

Description of Study Area

Tom Green County is located along the northern edge of the Edwards Plateau (fig. 1). The surface of the plateau in the northern, western, and southern parts of the county is characterized by low hills and few streams. An escarpment with a maximum height of about 100 ft separates the plateau areas from the plains in the central and northeastern parts of the county. Drainage is well developed in the plains. The altitude of the land surface ranges from about 2,570 ft above sea level in the southwest corner of the county to about 1,610 ft above sea level where the Concho River crosses the eastern boundary of Tom Green County.

The climate of Tom Green County is semiarid or steppe. Most precipitation occurs from convective showers and thunderstorms, with considerable variation in quantity, intensity, and areal coverage. The average annual precipitation at San Angelo is about 18 in., with about 80 percent occurring between March and November. Yearly precipitation has ranged from 7.41 in. during 1956 to 40.40 in. during 1936. Because of low humidity, strong winds, and hot summers, the gross lake-surface evaporation averages about 80 in. per year (Kane, 1967).

The Concho River and its main tributaries, the North Concho, Middle Concho, and South Concho Rivers, are the principal streams in the county. The Concho River, formed by the confluence of the North and South Concho Rivers in downtown San Angelo, flows easterly into Concho County. Several springs that flow from crevices in the Cretaceous limestone sustain the base flow of the Concho River in the southern and western parts of the county. Discharge from these springs increases after rainy seasons and decreases during droughts. Most tributaries of the principal streams are dry during most of the year.

There are three major reservoirs in the county. The oldest reservoir is Lake Nasworthy, which was built in 1930 and has a storage capacity of 12,390 acre-ft. The reservoir is located at the confluence of the South and Middle Concho Rivers about 3 mi south of downtown San Angelo. The O. C. Fisher Reservoir was built in 1952, has a conservation storage of 115,700 acre-ft, and is located on the North Concho River on the northwestern edge of San Angelo. Twin Buttes Reservoir was completed in 1962 and has a conservation storage of 186,200 acre-ft. Twin Buttes Reservoir impounds water from both the Middle and South Concho Rivers just upstream from Lake Nasworthy.

Rock formations exposed in the county are of sedimentary origin. The oldest rocks are of Permian age (table 1) and are exposed in some parts of the plains and river valleys. The regional dip of the Permian rocks is westward at about 50 ft/mi. The hilly remnants of the Edwards Plateau are composed of rocks of Cretaceous age, which dip slightly to the southeast. Older Quaternary alluvium and the Pleistocene Leona Formation cover the Permian rocks in most of the plains area, and younger Quaternary alluvium is present in the stream valleys.

All water wells considered in this report are completed in the shallow aquifer system (generally less than 400 ft deep) and yield fresh to moderately saline water (less than 10,000 mg/L dissolved solids). Water found deeper than 400 ft in the county usually is too mineralized for most uses and is classified as very saline or brine (more than 10,000 mg/L dissolved solids). The natural salinity of the shallow aquifer system generally reflects the circulation of water within the system. In the shallow, more permeable layers of the system, the circulation is faster than in deeper, less permeable layers; consequently, water has less dissolved solids in the shallow layers. The salinity of the ground water also is related to the mineralogy of the geologic material.

Table 1.--Stratigraphic units and their water-yielding properties

[modified from Willis, 1954]

System	Series and group		Formation	Thickness (feet)	Description of rocks	Hydrogeologic unit	Water-bearing characteristics
Quaternary	Holocene		Alluvium	0-50	Stream-channel deposits of clay, silt, sand, gravel, and caliche.	Leona aquifer	Yields small quantities of potable water for domestic and stock use.
			Unconformity				
Quaternary	Pleistocene		Leona Formation	0-125	Gravel and creviced conglomerate of limestone and flint fragments cemented with sandy lime or caliche and some layers of clay.	Leona aquifer	Yields potable water in sufficient quantities for irrigation where there are suitable saturated thicknesses of permeable material.
			Unconformity				
Cretaceous	Comanchean	Washita Group	Undifferentiated	20+	Argillaceous limestone and a few porous chalky layers.	Confining bed	No water supply.
Cretaceous	Comanchean	Fredericksburg Group	Edwards Limestone	50-200	Massive, resistant limestone and a few porous chalky layers. Contains numerous flint nodules.	Confining bed	No water supply.
Cretaceous	Comanchean	Fredericksburg Group	Comanche Peak Limestone	100	Massive resistant limestone. A few soft chalky and sandy layers.	Comanche Peak aquifer	Yields potable water in wells in the hilly area in the southern part of the county. Source of water for major springs in the hilly area.
Cretaceous	Comanchean	Fredericksburg Group	Walnut Clay	5-15	Yellowish sandy marl and clay.	Confining bed	No water supply.
Cretaceous	Comanchean	Trinity Group	Undifferentiated	20-103	Unconsolidated sand, concretionary sandstone, and clay. Conglomeratic at base.	Trinity aquifer	Yields small quantities of potable water in the southwest, northwest, and north-central parts of the country.
			Unconformity				

Table 1.--Stratigraphic units and their water-yielding properties--Continued

System	Series and group	Formation	Thickness (feet)	Description of rocks	Hydrogeologic unit	Water-bearing characteristics
Permian	Pease River Group	Blaine Gypsum	80-300	Red, brown, and cream-colored sandstone, Somewhat limy, gypsiferous, and pyritic; red, maroon, blue, and green sandy clay.	Blaine aquifer	Yields small quantities of highly mineralized water.
		San Angelo Sandstone	250	Brick-red sandstone,clay; some thin white sandstone seams, some gypsum, little or no mica, and one thin fossiliferous dolomite. Conglomeratic at base.	San Angelo aquifer	Yields small quantities of moderately to highly mineralized water.
		Unconformity				
	Clear Fork Group	Choza Formation	625	Gray dolomitic limestone, fossiliferous in places, red, green, blue, and yellow clay. Some silty clay layers.	Choza aquifer	Yields small quantities of moderately to highly mineralized water from layers of dolomitic limestone. Source of water for a few small irrigation wells.
		Bullwagon Dolomite Member	75	Massive yellowish to gray dolomitic limestone, and green and red shale layers. Two of the dolomitic limestone layers, about 10 feet thick, are separated by about 3 feet of green shale.	Bullwagon aquifer	Yields potable water in amounts significient for irrigation in a narrow area west of its outcrop.
		Vale Formation	140	About 8 feet of greenish shale at the top. Red, sandy, and gypsiferous shale and thin streaks of green shale.	Vale aquifer	Yields small quantities of moderately mineralized water.
		Standpipe Limestone Member	15	Yellowish to light-gray marly limestone.	Standpipe aquifer	Yields small quantities of potable water near its outcrop.
		Arroyo Formation	60+	Alternating light- to dark-gray and black layers of shale and fossiliferous limestone.	Arroyo aquifer	Yields small quantities of moderately to highly mineralized water from layers of limestone.

Oil and gas production in the county is from wells 800 to 7,000 ft deep, which are drilled through a deep regional aquifer system containing very saline water.

Method of Investigation

Available data on the shallow aquifer system in Tom Green County were compiled and analyzed to aid in the selection of wells for collecting current data about the shallow aquifers. In general, the selection of wells was based on the availability of historical data and on the areal and vertical distribution of the wells. Preference was given to wells with historic records so that hydrologic changes could be determined.

The 286 wells and springs listed in this report were located in the field and plotted on either 7-1/2-minute or 15-minute U.S. Geological Survey topographic maps. Water levels were measured in 280 wells, and the specific conductance of the well water was measured in 240 wells. Seven wells were measured monthly to monitor the seasonal fluctuation in water levels.

Current (1983) water levels and specific-conductance values were compared to historic values, and 30 wells were selected and sampled for more detailed water-quality analysis. Field analyses included specific conductance, pH, total alkalinity, and bacteriological quality; and laboratory analyses included dissolved concentrations of calcium, magnesium, sodium, potassium, sulfate, chloride, fluoride, and silica. Total hardness and SAR (sodium-adsorption ratio) were calculated from these analyses. Water samples from eight of these wells were analyzed for minor elements (arsenic, barium, chromium, copper, iron, lead, manganese, selenium, silver, zinc, and mercury) and nutrients (nitrogen and phosphorus). Three water samples were analyzed for selected pesticides.

Well-Numbering System

The local well-numbering system used in this report is the system adopted by the Texas Department of Water Resources for use throughout the State. Under this system, each 1-degree quadrangle in the State is given a number consisting of two digits. These are the first two digits in the well number. Each 1-degree quadrangle is divided into 7-1/2-minute quadrangles that are given two-digit numbers from 01 to 64. These are the third and fourth digits of the well number. Each 7-1/2-minute quadrangle is subdivided into 2-1/2-minute quadrangles and given single-digit numbers from 1 to 9. This is the fifth digit of the well number. Each well within a 2-1/2-minute quadrangle is given a two digit number in the order in which it was inventoried. These are the last two digits of the well number. The well location is shown on the map with only the last three digits of the well number adjacent to the well location. The second two digits are shown in the northwest corner of each 7-1/2-minute quadrangle, and the first two digits are shown by the large double-line numbers.

In addition to the seven-digit well number, a two-letter prefix is used to identify the county. The prefix for Tom Green County is YB. The prefix is used in the text, tables, and some illustrations.

The Geological Survey's national site-identification system uses the latitude-longitude coordinate system. The combination of the 6-digit latitude number, the 7-digit longitude number, and a 2-digit sequence number forms a 15-digit site-identification number. For example, the first site at latitude 32°15'42" and longitude 94°34'23" gives a site-identification number of 321542094342301. A cross reference between the State and national systems and well numbers from previous reports and the wells in this report are given in table 2 (Supplemental Information).

Well Construction

Well drilling in Tom Green County almost completely is done by cable tool or hydraulic rotary methods. For domestic wells, the borehole diameter is commonly 6 to 8 in., while for industrial and irrigation wells, the borehole diameter is usually 10 to 12 in. Well depth is selected primarily on the basis of desired well yield and quality of water. As expected, wells are drilled deeper for larger yields and may extend into underlying aquifers or strata that contain slightly saline water. Most of these deeper wells are screened into more than one aquifer, while some of the shallower domestic wells may be screened in a locally known stratum which yields water of good quality. For wells completed in very small-yielding aquifers, the borehole may extend tens of feet below the productive zone to provide additional water storage in the well bore.

The selection of well casing material and the well completion procedure is dependent on the type of rock encountered in the borehole. If rock is encountered throughout the borehole and there is little chance of caving, casing is used only at the surface. If the rock encountered is unconsolidated or semiconsolidated, casing and a well screen are required. Steel casing and screens were used prior to the early 1970's, but recently, plastic casing and screen commonly are used for the small-diameter wells. Unsorted gravel is used to fill the space between the casing and the well bore for wells constructed with steel casing. Gravel may not be needed for wells constructed with plastic screens because the very narrow and precise slots of plastic screens can hold back fine sand.

OCCURRENCE OF GROUND WATER IN THE SHALLOW AQUIFER SYSTEM

Limestone and conglomerate contain ground water in fractures, in solution-widened spaces between beds, and in solution channels, while sand and gravel contain ground water in pore spaces between the fragments of rock. These beds of rocks which contain and transmit water are called aquifers. Data from previous reports and current (1983) data indicate that water from shallow wells suitable for domestic and livestock uses may be found throughout most of Tom Green County except for an area just west and southwest of San Angelo where the Blaine Gypsum and San Angelo Sandstone, both of Permian age, out crop. Most usable ground water is less than 200 ft below the surface although some wells in the hilly areas exceed 300 ft in depth.

There are several aquifers that yield fresh to slightly saline water to wells in the county (table 1). The alluvial aquifer of Quaternary age, the youngest, is composed of clay, silt, sand, gravel, and caliche. It ranges in thickness from 0 to 40 ft. The Leona aquifer, also of Quaternary age, is composed of gravel, conglomerate, sandy lime or caliche, and thin layers of clay, and ranges in thickness from 0 to 125 ft. In this report the alluvial and Leona aquifers will be grouped together and will be called the Leona aquifer. A confining bed, consisting of the Washita Group and the Edwards Limestone, both of Cretaceous age, underlies the Leona aquifer.

In Tom Green County there are two aquifers of Cretaceous age in the Comanche Peak Limestone and the Trinity Group. The Comanche Peak aquifer is composed of massive resistant limestone with a few soft chalky and sandy layers, and it has a thickness of about 100 ft. The Trinity aquifer is composed of unconsolidated sand, sandstone, clay, and conglomerate at its base. The Trinity aquifer ranges in thickness from 20 to 103 ft.

Aquifers of Permian age include the Blaine, San Angelo, Choza, Bullwagon, Vale, Standpipe, and Arroyo. The Blaine aquifer, a minor aquifer in the study area, is composed of red, brown, and cream-colored sandstone, and red, maroon, blue, and green sandy clay. The aquifer ranges from 80 to 300 ft in thickness. The San Angelo aquifer is composed of red sandstone, clay, thin white sandstone, gypsum, one thin layer of dolomite, and a conglomerate at its base. Its thickness is about 250 ft. The Choza aquifer is composed of gray dolomitic limestone, red, green, blue, and yellow clay, and some silty clay layers. The thickness of this aquifer is about 625 ft. The Bullwagon aquifer, about 75 ft thick, is composed of massive yellowish to gray dolomitic limestone, and red and green shale layers. The Vale aquifer is composed of red, sandy, and gypsiferous shale and thin streaks of green shale with about 8 ft of green shale at the top. The aquifer is about 140 ft thick. The Standpipe aquifer is composed of yellowish to light-gray marly limestone and is about 15 ft in thickness. The Arroyo aquifer is composed of alternating light- to dark-gray and black layers of shale and limestone, and is from 60 ft to several hundred feet thick.

Maps showing the areal extent and potentiometric surface of each of the major aquifers in the county (figs. 2-4) were prepared from current (1932-83) water-level data from Willis (1954). The description of the stratigraphic units and their water-yielding properties (table 1) and hydrogeologic cross sections (fig. 5) are condensed from Willis (1954).

GROUND-WATER LEVELS

Ground-water levels rise or decline in response to several factors. Water-level fluctuations usually indicate changes in the amount of water in storage in the aquifer. If the discharge of ground water is equal to the recharge for a long period of time, the water level stays at the same altitude. If the recharge is greater, the water level rises, and if the discharge is greater, the water level declines. Large withdrawals or insufficient precipitation for a number of consecutive years could decrease the ground-water supplies and cause a decline in the water level.

Ground water in Tom Green County is discharged by seepage to the Concho River and its major tributaries, by springflow, by evapotranspiration in areas where the water table is at or near land surface, by underflow out of the

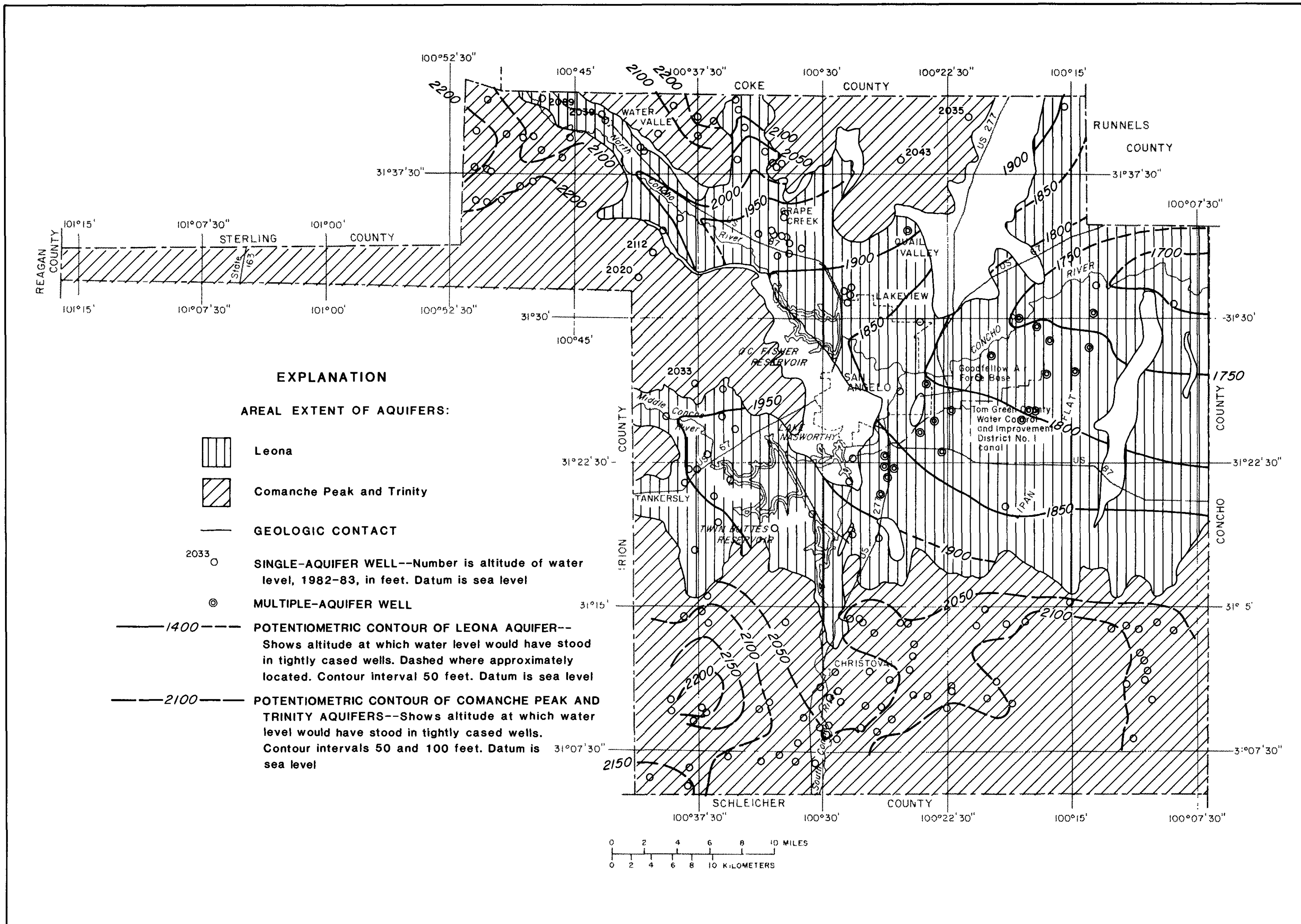

Figure 2.—Areal extent and potentiometric surfaces of Leona, Comanche Peak and Trinity aquifers, 1982-83.

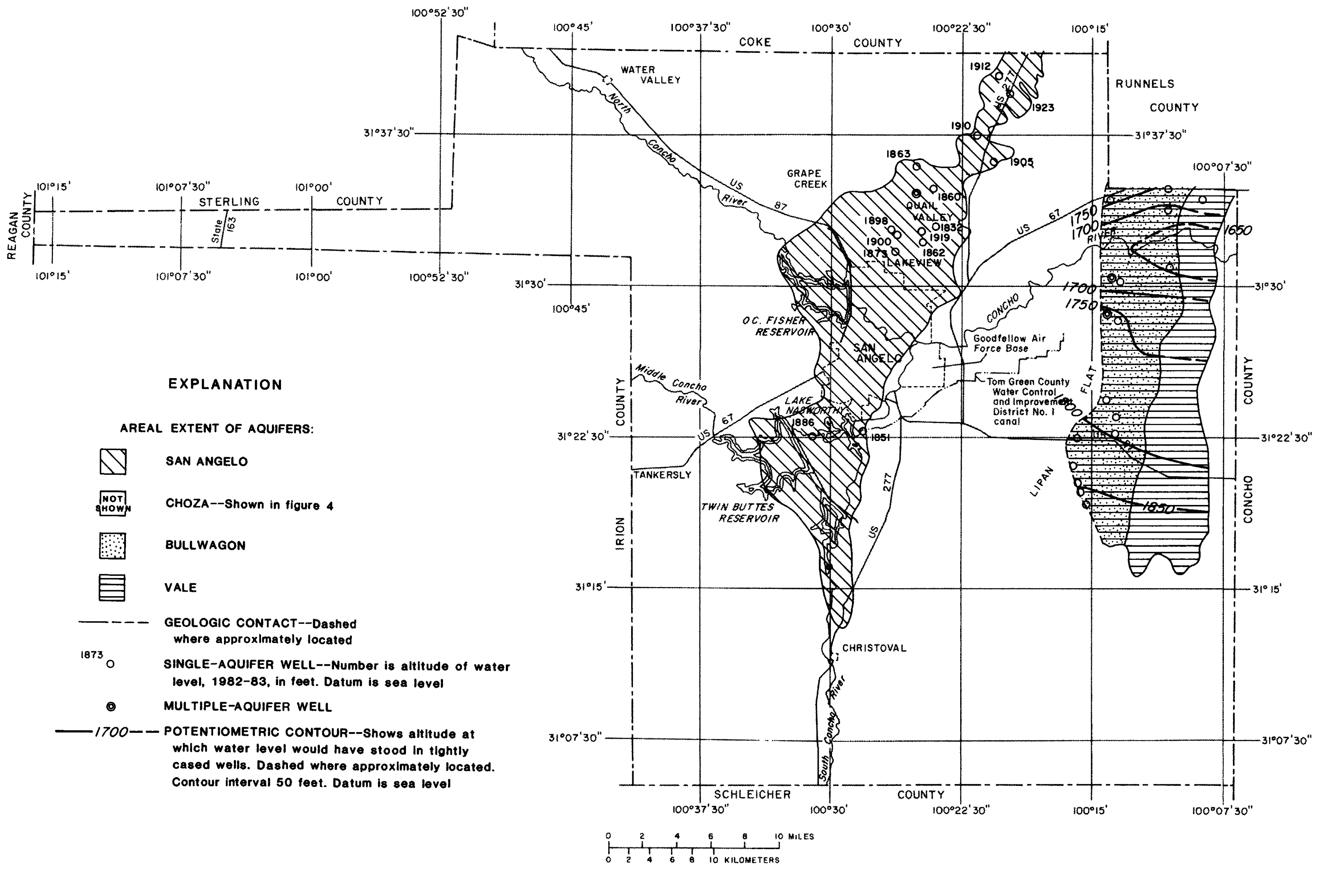

Figure 3.--Areal extent and potentiometric surfaces of San Angelo, Bullwagon and Vale aquifers, 1982-83.

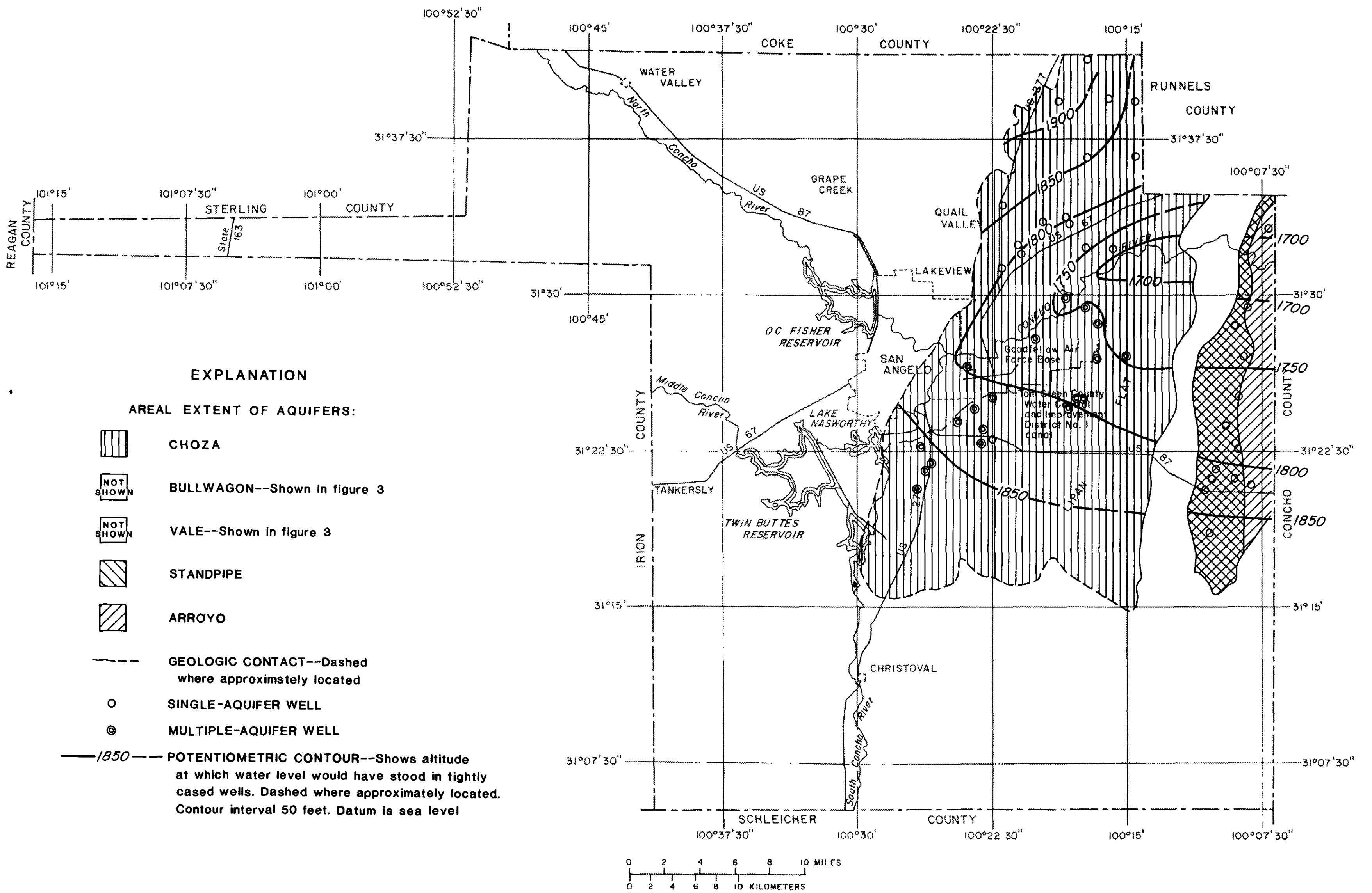

Figure 4.--Areal extent and potentiometric surfaces of Choza, Standpipe and Arroyo aquifers, 1982-83.

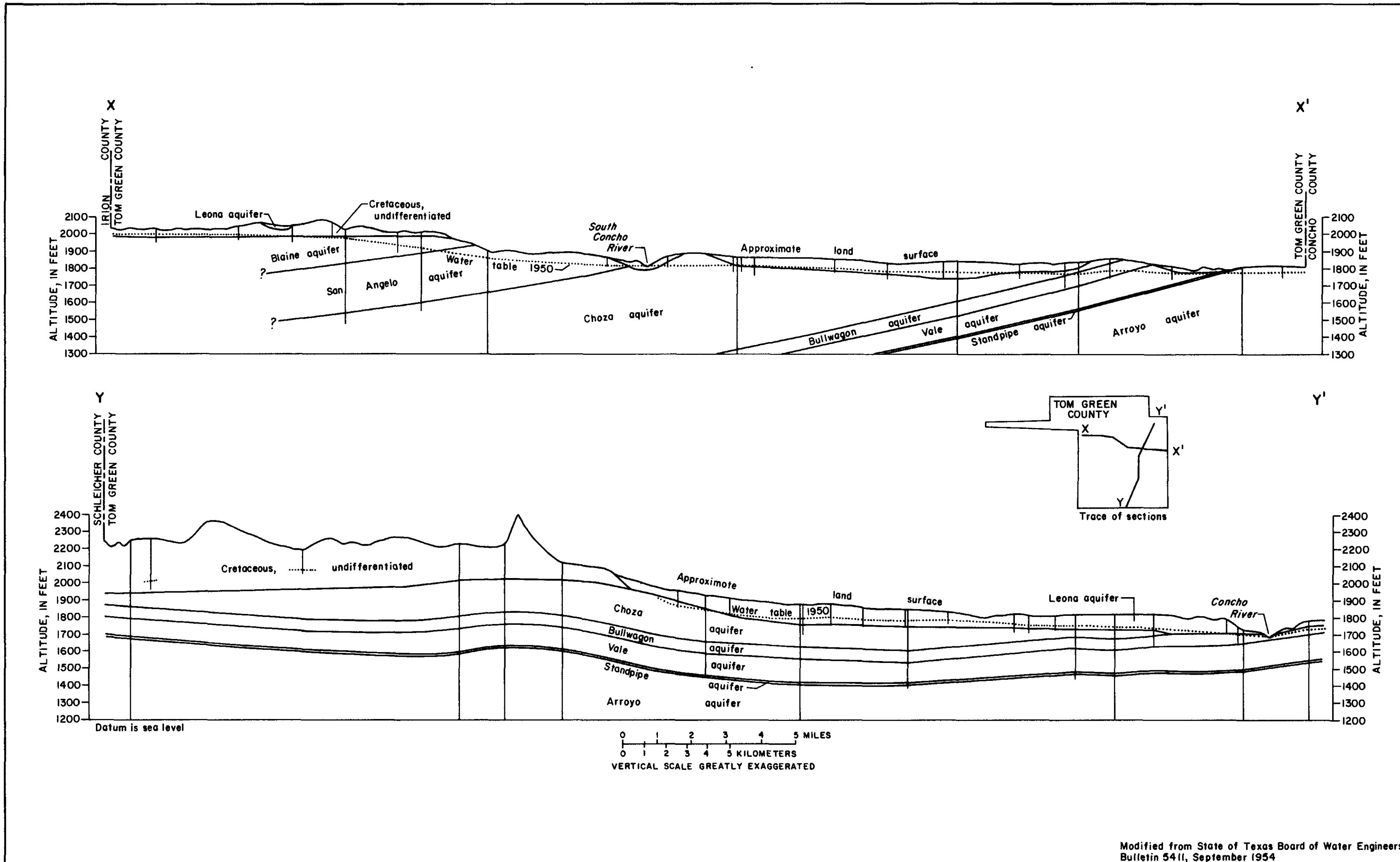

Figure 5.--Hydrogeologic sections showing structure of water-bearing formations.

county, and by pumpage from wells. Nearly all of the irrigation wells in the county are completed in the Leona, Choza, or Bullwagon aquifers, and are located along the river valleys or in Lipan Flat.

Recharge to the shallow aquifer system is almost totally dependent on local precipitation in the county; a small volume of underflow enters the county from the north, south, and west. Some recharge occurs in Lipan Flat through seepage from the Tom Green County Water Control and Improvement District No. 1 Canal when there is sufficient water in Twin Buttes Reservoir for irrigation (fig. 1). Also, excess irrigation water applied to crops will recharge the shallow aquifers through percolation. Additional recharge by seepage is believed to occur beneath the three reservoirs near San Angelo.

Current (1983) Conditions

Water levels in a representative number of wells (fig. 6) were measured from August 1982 through September 1983, and are listed in table 3 (Supplemental Information). The land-surface altitude at each well was estimated from 7.5- or 15-minute quadrangle maps, and the altitude of the water level was calculated from this datum. The water-level surfaces are highest in the hilly remnants of the Edwards Plateau and lowest along the Concho River and its tributaries (figs. 2-4).

Water levels in each aquifer generally are higher than in the underlying aquifers, indicating a downward flow. Along stretches of the Concho River, however, the head increases with depth and the flow is upward. This is expected because the Concho River is a discharge point for all the aquifers in the river valley. In the central and eastern part of the county, aquifers of Cretaceous and Permian age underlie the Leona aquifer (fig. 5) and are hydraulically interconnected. Water levels in the Comanche Peak and Trinity aquifers are similar and were contoured together (fig. 2), as were water levels in the Bullwagon and Vale aquifers (fig. 3), and in the Standpipe and Arroyo aquifers (fig. 4).

Because water-level measurements used to prepare the potentiometric-surface maps were collected over a 1-year period, the maps should be considered to represent a generalized surface. Short-term hydrographs (fig. 7) for selected wells measured during 1982-83 show no changes, slight changes, and changes of as much as 20 ft in water levels. Some of these selected wells are located in Lipan Flat, an area of extensive irrigation; the water levels in only a few wells were measured during periods of irrigation pumpage.

Historical Changes

Water-level changes over the last 30 to 40 years can be attributed to a number of factors such as different precipitation and pumping patterns, the construction of the Tom Green County Water Control and Improvement District No. 1 Canal, the formation of the Millersview-Doole Rural Water System, and changes in well construction after collapse or deterioration of casing. Errors in well identification or measurement also can result in apparent water-level change. Construction of the District No. 1 Canal allowed surface water to be brought to farms, thus farmers could substantially reduce or discontinue ground-water withdrawals for irrigation. Seepage from the canal and deep percolation

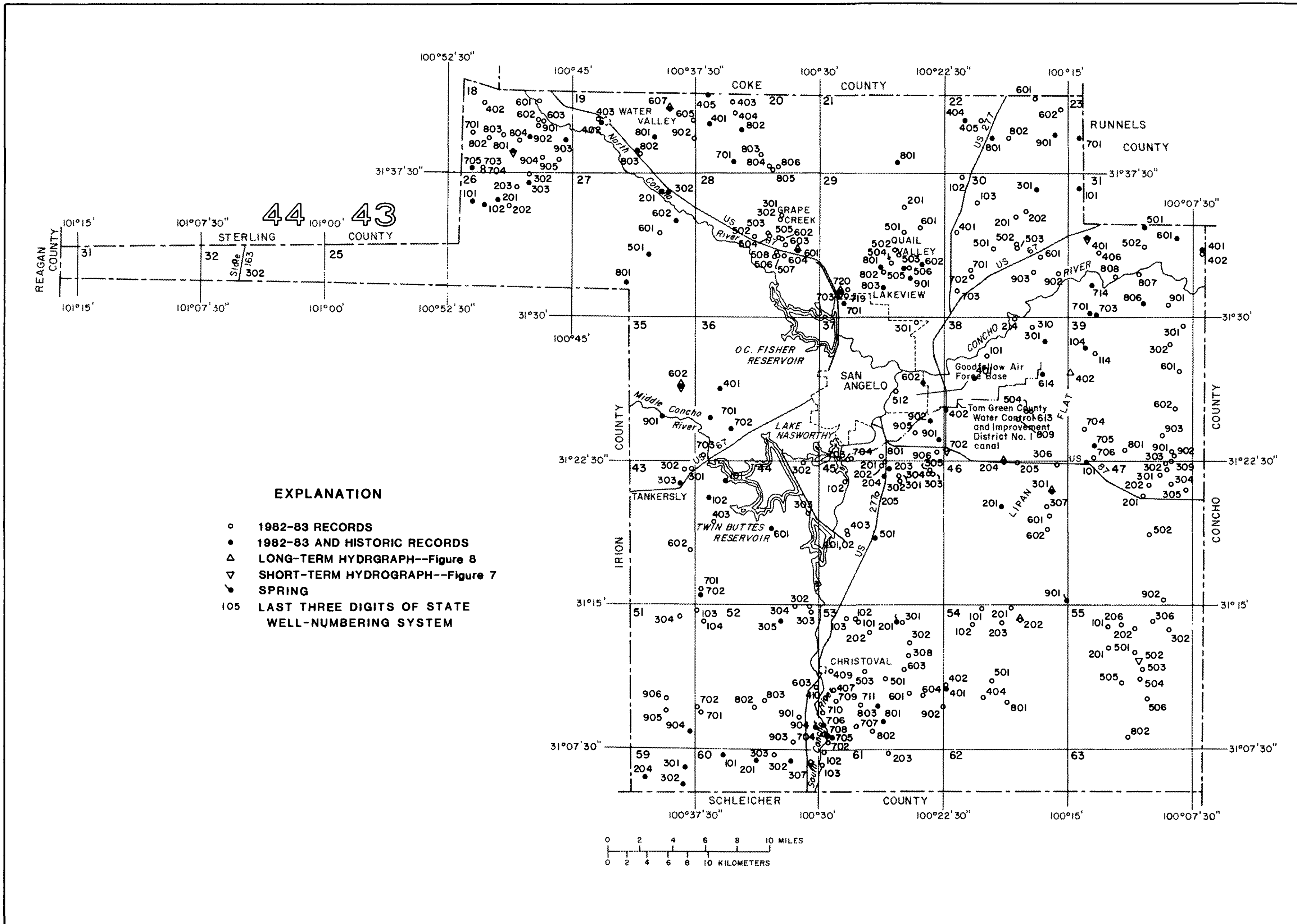

Figure 6.--Location of wells and springs where water levels were measured, April 1982 to September 1983.

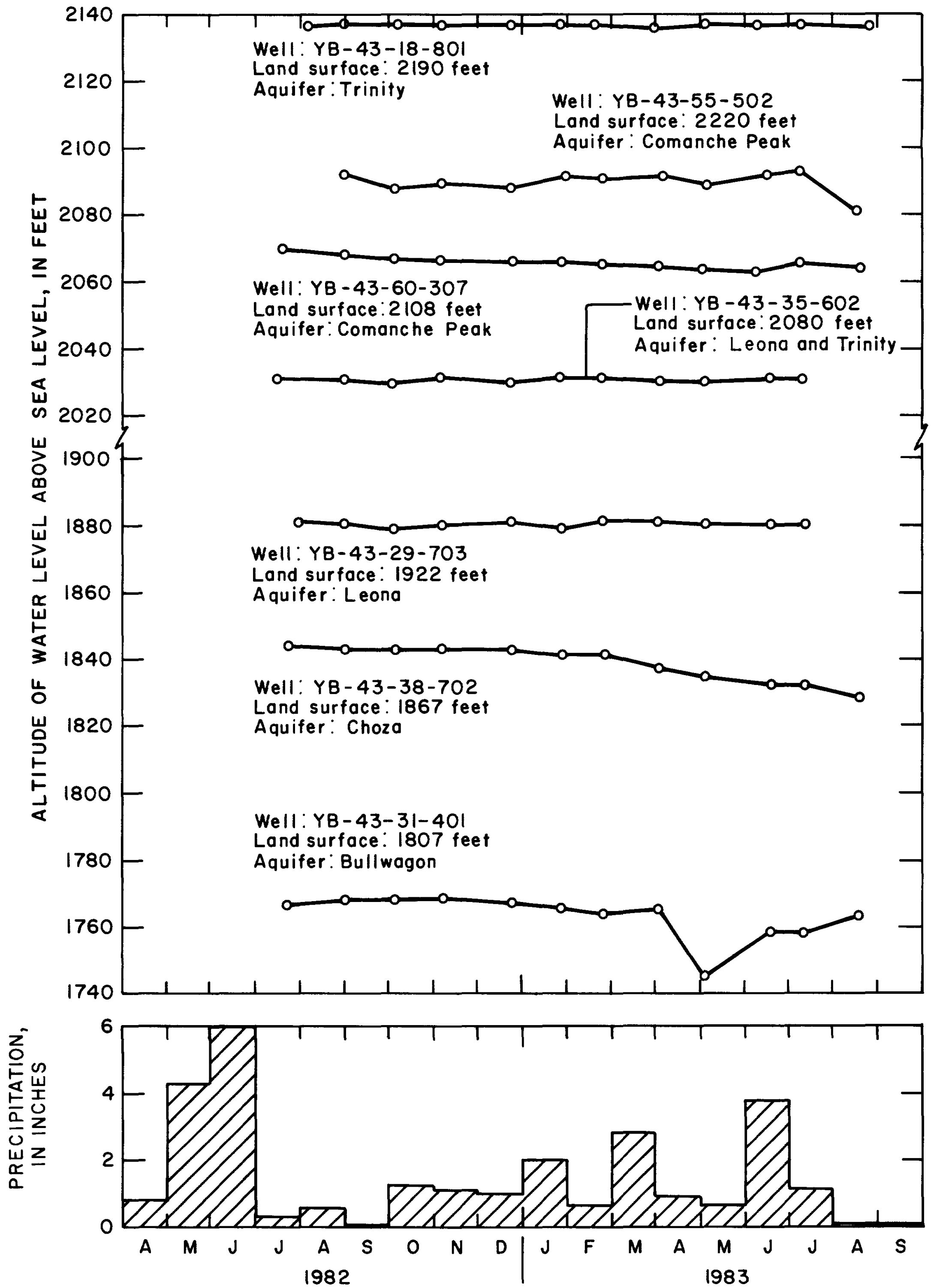

Figure 7.--Hydrographs for selected wells and monthly precipitation at San Angelo, April 1982 to September 1983.

of excess irrigation water also provided recharge to the shallow aquifers. Likewise, the Millersview-Doole Rural Water System, which provides drinking water to rural residents, has resulted in a decrease in ground-water withdrawals for domestic use.

To show the long-term trend of the water levels in the county, long-term hydrographs for eight wells were plotted along with the yearly precipitation at San Angelo (fig. 8). Water levels were obtained from previous reports (Work Projects Administration, 1941; Willis, 1954) and from records on file with the Texas Department of Water Resources. Precipitation records for San Angelo were obtained from the U.S. Department of Agriculture (1936-40) and U.S. Department of Commerce (1941-80). The eight wells are distributed throughout the county (fig. 6) and are representative of the different areas and aquifers. The hydrographs indicate a direct correlation between water levels and precipitation. Generally, water levels rise following periods of above-normal precipitation (accompanied by decreased pumpage for irrigation) and decline during periods of below-normal precipitation (accompanied by increased pumpage for irrigation).

The wells with the largest fluctuation of water levels are irrigation wells located in the Lipan Flat area. These wells (YB-43-39-402, YB-43-46-204, and YB-43-46-301), tap different aquifers and have similar hydrographs. The hydrographs for all three wells show a small peak in 1949, and a gradual decline of about 30 ft by the latter part of 1956. This coincides with the 1950's drought when pumpage for irrigation was great. From 1956 to 1962, water levels rose about 40 ft in well YB-43-39-402 and about 70 ft in well YB-43-46-301. This rise was caused by the above-normal precipitation in 1957, 1959, and 1961 and an accompanying decrease in irrigation pumpage. Water levels then declined until 1968 as a result of increased pumpage for irrigation. In 1969, the water level rose 40 to 60 ft in this area; from 1969 to 1983 it has fluctuated no more than about 25 ft. The precipitation was above normal for 10 of the years during 1967-81, and the use of surface water for irrigation began in 1972, which reduced the volume of ground water needed for irrigation.

Comparison of current (1983) water levels and historic water levels published in previous reports (Work Projects Administration, 1941; Willis, 1954) shows that water levels over much of the county generally have fluctuated less than 10 ft (fig. 9). Figure 9 may be somewhat misleading, however, because the short-term hydrographs of selected wells (fig. 7) show that the altitude of the water table in shallow aquifers may fluctuate by as much as 20 ft due to seasonal changes in withdrawals. Large seasonal changes usually are limited to areas of pronounced ground-water withdrawals. Water levels in areas of small ground-water withdrawals appear to have seasonal changes of 8 ft or less (fig. 7).

There are three areas where water levels have changed more than 10 ft--in the northwest corner of the county around Water Valley, just north of San Angelo in the Lakeview and Quail Valley areas, and in the Lipan Flat area (fig. 9). Ground water in the northwest corner of the county is obtained from the Trinity aquifer in the hilly plateau areas and from the Leona aquifer in the river valley and flats. The water-level changes are extremely variable in this area. Well YB-43-18-702 in the Trinity aquifer recorded a long-term water-

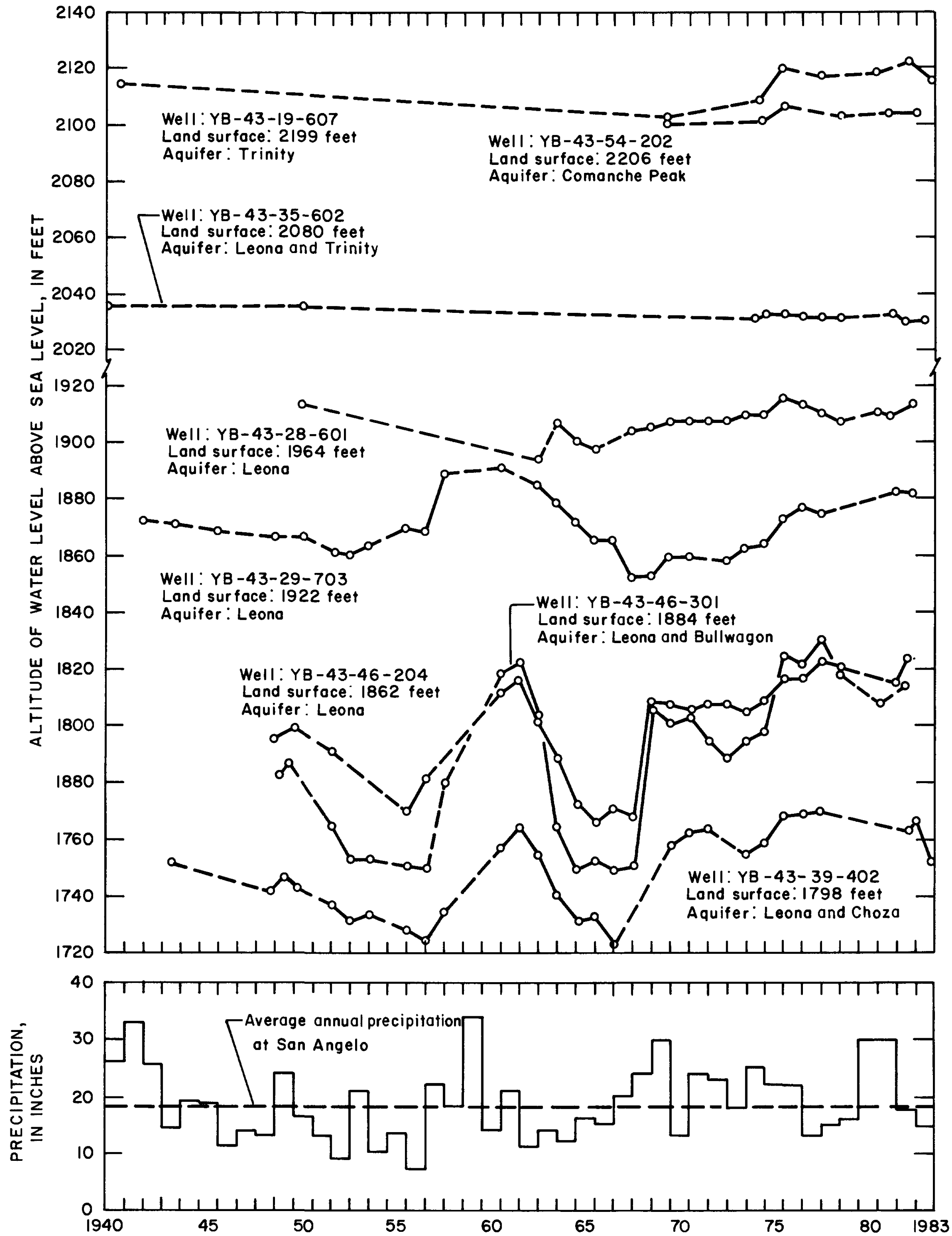

Figure 8.--Hydrographs for selected wells and average annual precipitation at San Angelo, 1940-83.

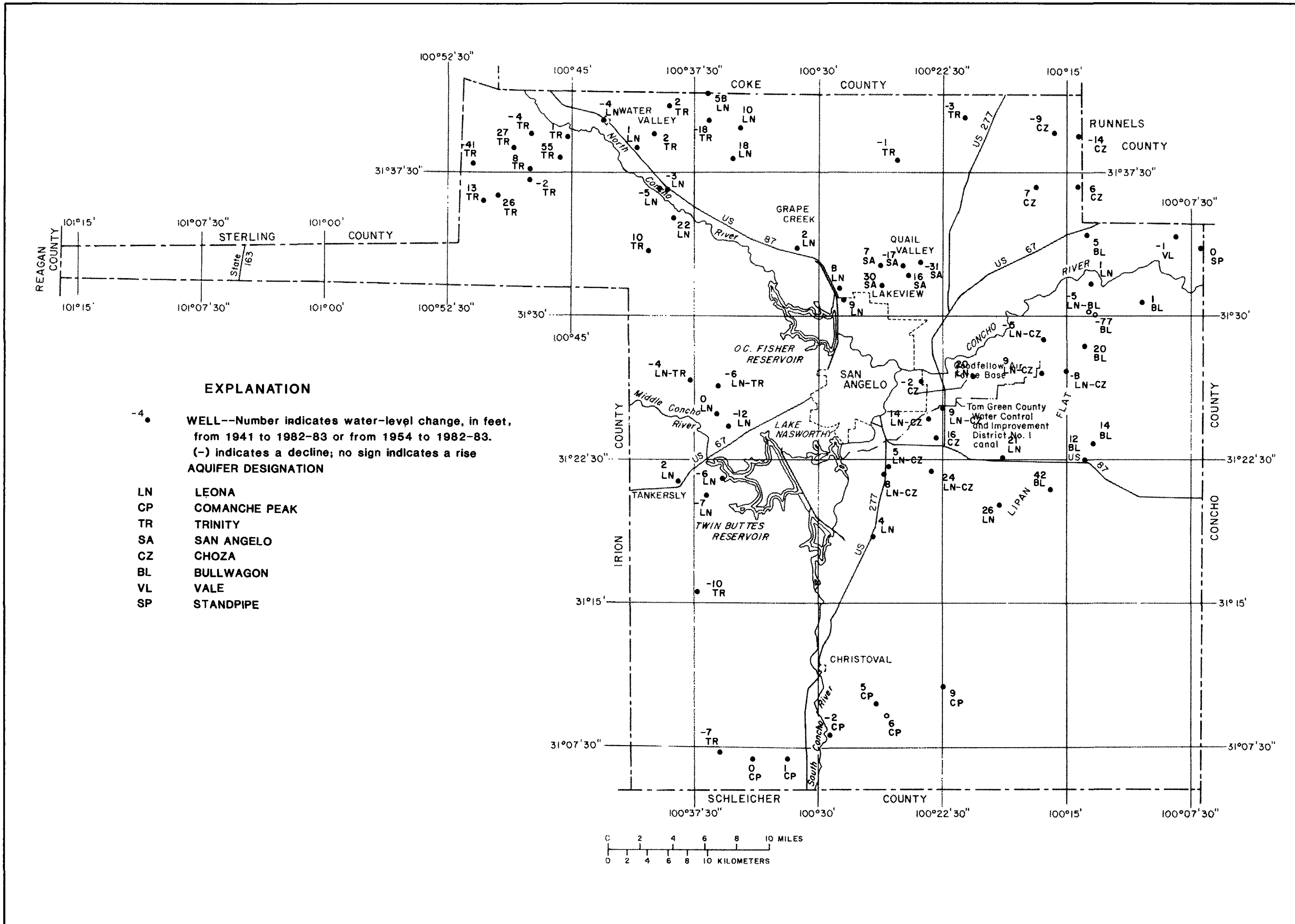

Figure 9.--Water-level changes in selected wells, 1941 or 1954 to 1982-83.

level decline of 41 feet, while well YB-43-18-905, also in the Trinity, and well YB-43-20-405 in the Leona aquifer had water-level rises of 55 and 58 ft, respectively. Although well YB-43-18-702 (with a 41-ft decline) is located in an area of generally rising water levels, the long-term decline, or apparent decline, in water level may be caused either by some change in the well itself (collapsed casing, plugged slots in casing, etc.) or by an erroneous measurement of the water level. The uncharacteristic long-term rise in water level at well YB-43-18-905 (with a 55-ft rise) may be caused by a water-level measurement taken during a heavily-pumped period in July 1950, or by an erroneous measurement. The long-term rise in water level at well YB-43-20-405 (a rise of 58 ft) probably is correct. This well was measured in 1969 by State personnel and indicated a water-level rise of 26 ft from the initial measurement in 1950. If these three wells are disregarded, long-term water-level changes in the area around Water Valley range from a decline of 18 ft to a rise of 27 ft. A slight rise in water levels is typical of the area for the period of record and probably is the result of infiltration of above-normal precipitation just prior to the 1982-83 measurements. Most of the wells in the northwest part of the county are used for domestic and livestock purposes; therefore, the pumpage is small.

Wells located in the area just north of San Angelo obtain water primarily from the San Angelo aquifer. Of the five wells with long-term water-level records in this area (fig. 9), two wells show large water-level rises, two wells have large water-level declines, and one well shows a slight water-level rise. The well yields in this area usually are very small (less than 5 gal/min), and some wells in the area have gone dry during periods of little precipitation. Sufficient data are not available to explain these differences in water-level changes.

The third area with large long-term water-level changes is located in the Lipan Flat area. Lipan Flat is the major farming area in the county and has most of the irrigation wells. Wells in this area produce water from the Leona, Choza, Bullwagon, or a combination of these aquifers. In general, this area has had a long-term rise in water levels, and only a few isolated wells have had declines. Only well YB-43-31-703 has had a water-level decline of more than 10 ft. This well produces water from the northern part of the Bullwagon aquifer and has had a water-level decline of 77 ft from 1948 to 1984. The water level declined 51 ft from 1948 to 1950 and then declined another 14 ft from 1950 to 1952. From 1952 to 1984 the water level declined only 12 ft. Well YB-43-46-301, located in the southern part of the Bullwagon aquifer, has had a rise of 42 ft, the largest rise in water levels in the Lipan Flat area. Water levels in well YB-43-46-301 and other wells located in areas of intensive pumpage for irrigation fluctuate greatly from wet years to dry years when irrigation demands are greater (fig. 8). If both wells mentioned above are discounted, there has been an average water-level rise of about 11 ft in the Lipan Flat area. This rise may be the result of a number of factors:

1. Below-normal precipitation resulted in more irrigation pumpage in the early 1950's than during 1982-83.
2. Surface water diverted into the area by the Tom Green County Water Control and Improvement District No. 1 Canal has caused less ground water to be used for irrigation. Since 1972, about 19,000 acre-ft of water per year has been provided to the District, which receives water from Twin Buttes Reservoir.

3. Irrigation water from Tom Green County Water Control and Improvement District No. 1 Canal and seepage from the canal provided increased recharge to the aquifer.

4. The Millerview-Doole Rural Water System, which obtains water from deep wells located east of Tom Green County, began supplying water for domestic and livestock uses throughout much of the area. Use of this imported water reduced the ground-water withdrawals from the shallow aquifers in the area.

GROUND-WATER QUALITY

Large variations occur in the chemical quality of ground water in Tom Green County. These variations are caused partly by the mineral composition of the geologic materials forming the different aquifers, but waters from the same aquifer also can have differing chemical qualities. To allow the reader to readily compare the quality of water found in the aquifers, public water-supply maximum contaminant levels established by the U.S. Environmental Protection Agency (1976; 1977a) for selected constituents and properties are provided in tables 4 and 5 (Supplemental Information). The location of the wells and springs which were sampled are shown in figure 6.

Current (1983) Conditions

To indicate the current (1983) ground-water-quality conditions in Tom Green County, the following measurements and laboratory determinations were made:

1. Specific conductance and dissolved-solids concentrations were determined in the field for 236 wells and 4 springs (table 6, Supplemental Information).

2. Water samples for 46 wells were tested for bacteriological quality (fecal and fecal-streptococci coliforms) as an indication of possible septic pollution throughout the county (table 7, Supplemental Information). Twelve of the wells were in urban areas that had no central sewer systems and were served by septic systems.

3. Thirty wells were sampled for more detailed analysis (table 7). They were selected on the basis of comparisons between historic water-quality data and current (1983) water-quality data. Field and laboratory analyses included specific conductance, pH, total alkalinity, and bacteriological quality on all samples. U.S. Geological Survey laboratory analyses included: Dissolved concentrations of calcium, magnesium, sodium, potassium, chloride, fluoride, sulfate, and silica on all 30 samples; arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, silver, zinc, nitrogen, and phosphorus for 8 samples; and selected insecticides for 3 samples.

Dissolved-Solids Concentrations

Dissolved-solids concentrations are widely used in describing water quality and comparing water types. The distribution of measured or estimated dissolved-solids concentrations for wells and springs in Tom Green County is shown in figure 10. Dissolved-solids concentrations were measured in the laboratory analyses (table 7A) for samples collected from selected wells. For the remainder of the wells, the dissolved-solids concentrations were estimated

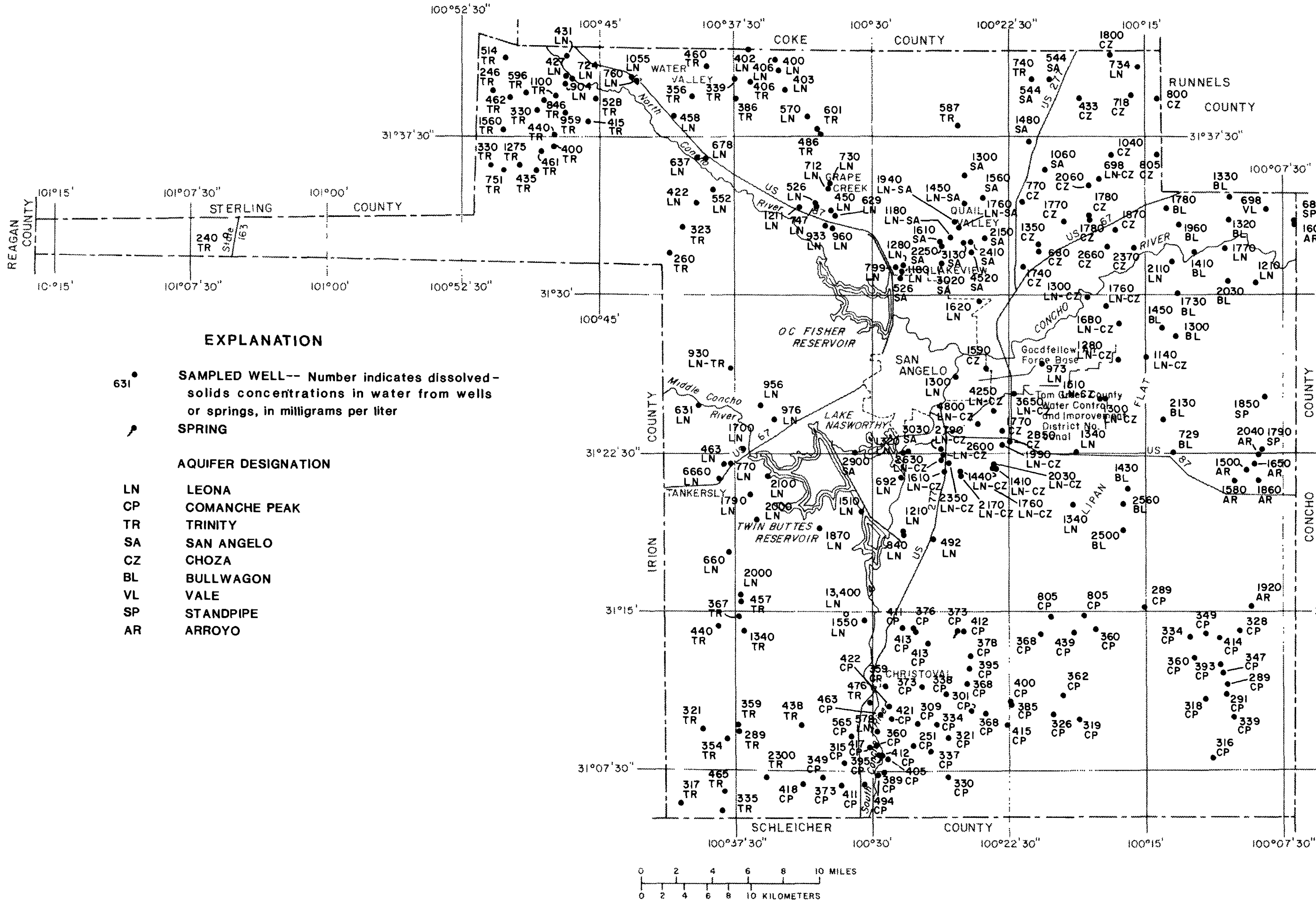

Figure 10.--Measured or estimated disslved-solids concentrations in water samples collected from wells and springs, 1982-83.

from the specific conductance of the water, which was measured for all wells from which a water sample could be obtained (table 6). Using the specific-conductance measurements and dissolved-solids concentrations of the samples where a complete analysis was taken, a mathematical relationship between dissolved-solids concentrations and specific conductance was computed. This relationship is:

$$\text{Dissolved-solids concentration} = \text{specific conductance} \times 0.58 + 28 \quad (1)$$

where dissolved-solids concentration is in milligrams per liter; and specific conductance is in microsiemens per centimeter at 25°C.

The average error of the estimated versus measured dissolved-solids concentrations is 5 percent for the 49 samples listed in table 6. The greatest errors occur in water with large sulfate and small chloride concentrations, where the estimated value may be about 25 percent too small. Conversely, waters with large chloride and small sulfate concentrations are estimated to have computed concentrations that are too large; however, these errors are usually less than 10 percent.

Water quality is highly variable throughout the remainder of the county. Except for wells tapping the Comanche Peak and Trinity aquifers, wells throughout most of Tom Green County do not produce water with dissolved-solids concentrations below the 500 mg/L level suggested for public water systems (table 4). The largest concentration of dissolved solids was from well YB-43-52-304, which had 13,400 mg/L (table 6). This well is most likely affected by a nearby plugged and abandoned oil-production well or an abandoned oil test well. The ground water with the second largest concentration of dissolved solids (6,660 mg/L) was from well YB-43-43-302 in Tankersly in the west-central part of the county. This well is reported to produce water from the Leona aquifer, but may also be completed in the underlying Permian formations which are known to contain water having extremely large dissolved-solids concentrations. The ground water with the smallest dissolved-solids concentrations comes from wells in the Comanche Peak aquifer or from the underlying Trinity aquifer. These wells are in the hilly areas in the northern and southern parts of the county. In these areas, the soil is not suited for irrigation, so most wells are used for domestic and livestock use, therefore, the volume of water withdrawn from the aquifers is small. Most of these wells generally have small yields (5 to 50 gal/min), but some may yield as much as 500 gal/min.

Ground water from the Comanche Peak and Trinity aquifers generally contains dissolved-solids concentrations of less than 1,000 mg/L; most concentrations are less than 500 mg/L. However, ground water in two small areas has larger concentrations. In the northwest corner of the county, in the Water Valley oil field, ground water contains dissolved-solids concentrations ranging from 1,275 to 1,560 mg/L, and may be affected by oil-field activities. In the southwest part of the county, water from well YB-43-60-101 has dissolved solids of about 2,300 mg/L. This well is not located in an oil-producing area, but there have been several oil tests drilled in the vicinity. Willis (1954) lists well YB-43-60-101 as being completed in both the Trinity and the San Angelo aquifers, and the well could be affected by poor quality water from the San Angelo Sandstone.

The remainder of the county draws most of its ground water from the alluvial aquifer in the river valleys, and from the Leona, San Angelo, Choza, and Bullwagon aquifers, although some ground water in the far eastern part of the county comes from the Vale, Sandpipe, and Arroyo aquifers. The dissolved-solids concentrations of water in these aquifers usually varies between 1,000 and 3,000 mg/L, but some samples had concentrations greater than 3,000 mg/L. These values clearly exceed the maximum level for secondary drinking-water standards set by the U.S. Environmental Protection Agency (1977a).

Major Inorganic Constituents and Physical Properties

Water samples were collected from 29 wells and from Anson Springs (fig. 11), and analyzed to determine the general water-quality characteristics of the shallow aquifers in the county (table 7). These wells were selected on the basis of the following factors--available historic data, aquifer source, well type, water use, and location. The criterium was to select representative wells that would reasonably describe the overall water-quality characteristics of the ground water in the county.

The Stiff diagrams (fig. 11), drawn from the analyses of water samples mentioned above, show dissolved-solids concentrations and the proportions assigned to selected major ions. These diagrams indicate the different chemical types of water for each aquifer and can be used to help identify any mixing of waters. The major inorganic constituents and physical properties are discussed for each aquifer in this report.

Leona Aquifer

Water samples from seven wells in the Leona aquifer were analyzed for their chemical constituents. Of these samples, four are classified as freshwater (less than 1,000 mg/L dissolved solids). Wells YB-43-19-402 and YB-43-28-602, contain the best water and are located northwest of San Angelo in the North Concho River valley. The water is basically a calcium and magnesium bicarbonate type. Water from well YB-43-28-602 may be the most representative of the native water in the Leona aquifer. The other two wells, YB-43-43-301 and YB-43-45-401, located south and southwest of San Angelo, have calcium carbonate and sodium chloride type waters, which indicate possible mixing.

The Stiff diagrams of slightly saline water from three wells (YB-43-31-714, YB-43-44-403, and YB-43-44-701) do not resemble each other. Water from the three wells had dissolved-solids concentrations of about 2,000 mg/L and large concentrations of sodium and chloride (fig. 11). Well YB-43-44-403 is in an oil field, and the land owner reported it to be polluted by seepage from a plugged and abandoned oil-test well. However, all three wells may receive some water from the underlying Permian System. This could explain the above-normal concentrations of sodium and chloride in the water. Well YB-43-52-304, sampled in June 1983, had an estimated dissolved-solids concentration of 13,400 mg/L (table 6) which probably was caused by seepage from a plugged and abandoned oil-test well. Concentrations for the major chemical constituents and properties of water in the Leona aquifer are shown in figure 12. Data indicate that the water in the Leona aquifer ranges from fresh to slightly saline and is very hard. The secondary maximum contaminant levels set by the U.S. Environmental

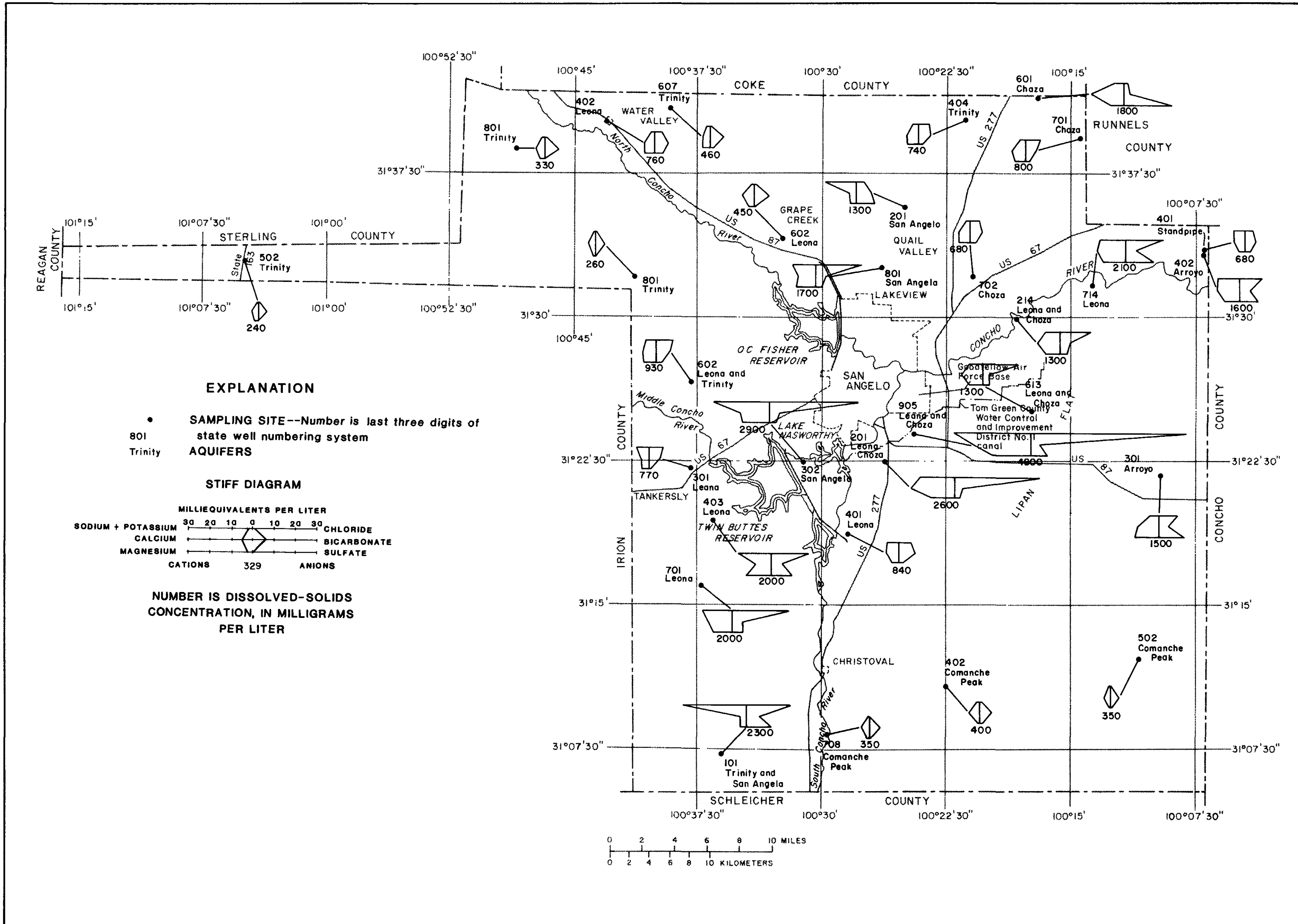

Figure 11.--Distribution and relative concentrations of major ions.

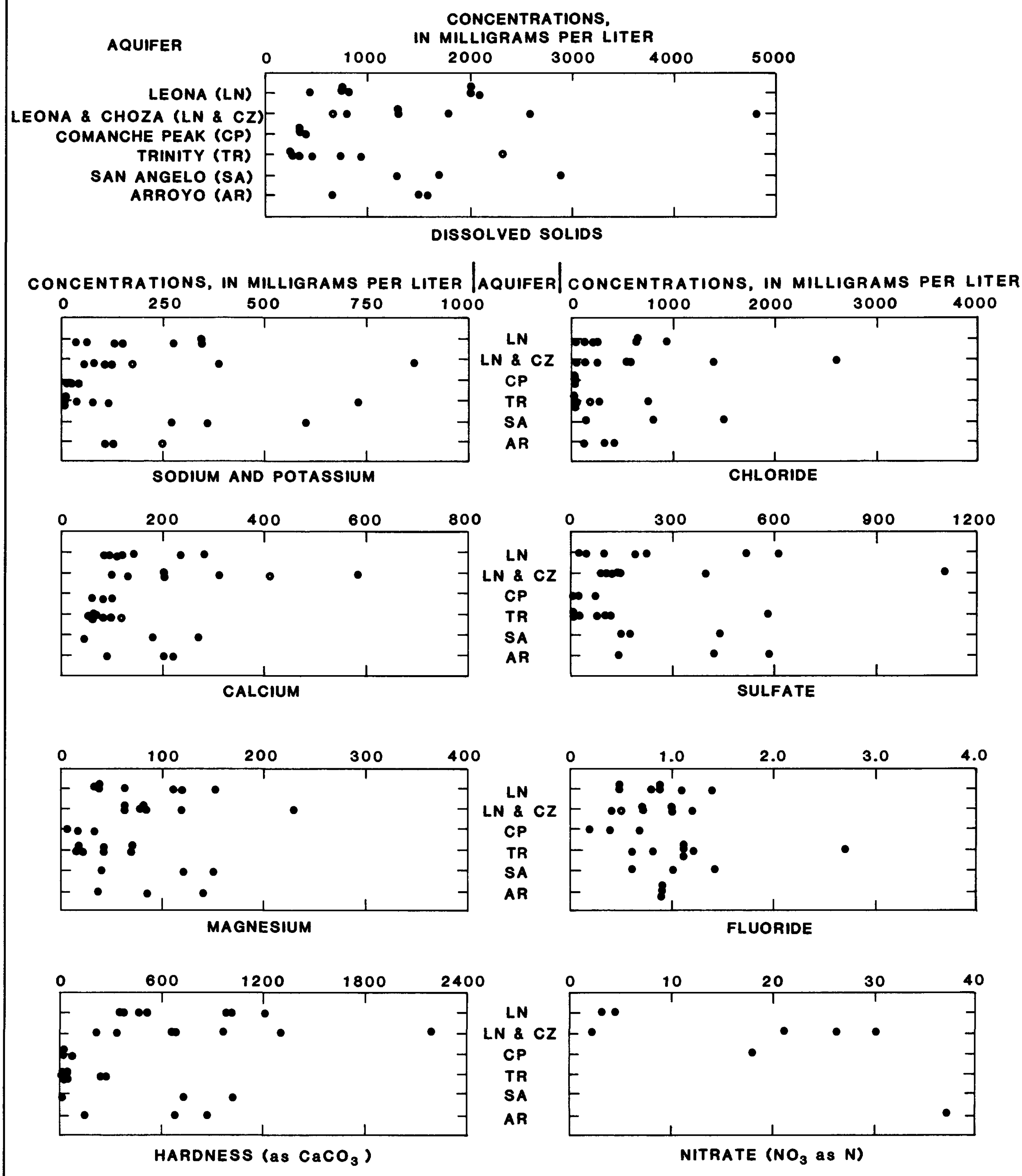

Figure 12.--Concentrations of major ions and dissolved solids categorized by aquifer.

Protection Agency (table 4) for a public water system were exceeded in water samples from six wells for dissolved solids, from two wells for sulfate, and from four wells for chloride.

Leona and Choza and Choza Aquifers

Many of the wells in the Lipan Flat area penetrate both the Leona and Choza Formations and produce water with large dissolved-solids concentrations; these wells are included in the analyses of water samples from wells in the Choza aquifer. Drillers commonly screen most water-yielding sand layers to increase the well yield, and often the lower part of the Leona aquifer is screened along with the Choza aquifer.

Water samples from seven wells in the Leona and Choza and Choza aquifers were analyzed for their chemical constituents (table 7A). Water from only two of these wells (YB-43-23-701 and YB-43-30-702) have dissolved-solids concentrations that are considered to be freshwater. The Stiff diagrams for these two wells (fig. 11) are similar; the major cations are calcium and magnesium in nearly equal proportions, the major anions are chloride and becarbonate in nearly equal proportions, and both have very little sodium or sulfate.

Well YB-43-22-601 in the northeast corner of the county is the only well in the Choza aquifer that had sulfate as the predominant anion. The well has a calcium sulfate type water with some sodium and magnesium and very little chloride or bicarbonate. This well is deep (238 ft) for this area of the county and is completed entirely in the Choza aquifer.

Two wells east of San Angelo (YB-43-38-214 and YB-43-38-613), one located near the Concho River and one located in the center of Lipan Flat, have almost identical Stiff diagrams and dissolved-solids concentrations (1,300 mg/L). The water is a calcium chloride type with large concentrations of sodium and magnesium and very little bicarbonate and sulfate.

The remaining two wells (YB-43-37-905 and YB-43-45-201) are located just southeast of San Angelo in an area that contains some of the largest dissolved-solids concentrations found in water wells during the study. Well YB-43-37-905 contains sodium chloride type water with large amounts of calcium and magnesium and very little bicarbonate and sulfate. The dissolved-solids concentration was 4,800 mg/L. Well YB-43-45-201 contains a calcium chloride type water with large concentrations of sodium and magnesium and very little bicarbonate and sulfate. The dissolved-solids concentration was 2,600 mg/L. Water from wells in the Leona and Choza and Leona aquifers ranges from fresh to moderately saline, is very hard, and exceeds the secondary maximum contaminant level set by the U.S. Environmental Protection Agency (table 4) for a public water system in two wells for sulfate, in five wells for chloride, and in three wells for nitrate (fig. 12).

Comanche Peak Aquifer

Water samples from Anson Springs and two wells in the Comanche Peak aquifer were analyzed for principal chemical constituents (fig. 12). Water from the Comanche Peak aquifer is similar to water from the Trinity aquifer. Stiff diagrams for Anson Springs (YB-43-53-708) and wells YB-43-54-402 and YB-43-55-502 indicate that the water is of the calcium bicarbonate type with dissolved-solids concentrations of less than 400 mg/L. This water is very similar to the two wells (YB-43-19-402 and YB-43-45-401) sampled in the Leona aquifer.

Trinity Aquifer

Water samples from seven wells in the Trinity aquifer were analyzed for chemical constituents (fig. 12). Samples from wells YB-43-18-801, YB-43-27-801, and YB-44-32-502 contain calcium bicarbonate type water, which is believed to be typical of the Trinity. The water from these wells had the smallest concentrations of dissolved solids of all the wells sampled during the study. The other four wells, two of which also tap adjacent aquifers, do not follow this pattern. The Stiff diagrams (fig. 11) indicate that the water in the Trinity has been mixed with water from other sources. In water from three wells (YB-43-19-607, YB-43-22-404, and YB-43-35-602), calcium is still the dominant cation, but not the predominant cation (more than 50 percent). In all three of these wells, the magnesium cation is nearly equal to the calcium, and the sodium cation is more than one-half the value of the calcium. On the anion side of the Stiff diagrams, chloride increased in two of the samples and in the other, bicarbonate is still the predominant anion. The Stiff diagram for water from the remaining well (YB-43-60-101) does not resemble the diagrams for water from the other wells in the Trinity aquifer because the well also is open to the San Angelo aquifer and possibly to the Blaine Gypsum. Mixing of water from different aquifers makes it difficult to assess the effects of oil-field activities on water quality.

The water from wells in the Trinity aquifer (well YB-43-60-101 not included) is classified as freshwater, but very hard. None of the principal constituents exceed the maximum set by the U.S. Environmental Protection Agency (table 4). The only objection to the water is its excessive hardness.

San Angelo Aquifer

Water samples from three wells in the San Angelo aquifer were analyzed for principal chemical constituents (fig. 12). As shown by the Stiff diagrams (fig. 11), the quality of water seems to worsen and change in type from north to south. Well YB-43-29-201, a 275-ft deep well located about 8 mi north of San Angelo, contains slightly saline water (1,300 mg/L dissolved-solids concentration) of the sodium sulfate type. Well YB-43-29-801, about 4 mi south of the above well and just north of San Angelo, also produces slightly saline water (1,700 mg/L dissolved-solids concentration) but of the sodium chloride type. Well YB-43-44-302, located between Twin Buttes Reservoir and Lake Nasworthy, produces water similar to well YB-43-29-801 but has a larger dissolved-solids concentration (2,900 mg/L).

Water from wells in the San Angelo aquifer is slightly saline and very hard. All water samples from this aquifer exceeded the secondary maximum contaminant level for dissolved-solids concentrations of 500 mg/L set by the U.S. Environmental Protection Agency (table 4) for public-water supply. Water from well YB-43-29-201 exceeded the standards for sulfate; water from the other two wells did not exceed the sulfate maximum, but did exceed the maximum for chloride.

Bullwagon and Vale Aquifers

Water samples from the Bullwagon and Vale aquifers were not collected for analysis of the principal chemical constituents. The Bullwagon Dolomite Member of the Vale Formation, supplies water for many irrigation wells located west (downdip) of the outcrop in the eastern part of the county. The dissolved-solids concentrations computed from the specific conductance of water samples from 17 wells in the Bullwagon aquifer varied from 729 to 2,560 mg/L (table 6), which is similar to water from the Leona and Choza aquifers in the immediate area.

The other members of the Vale Formation yield little or no water. Only one well (YB-43-31-601) was inventoried and reported by Willis (1954) as drawing water from a member of the Vale Formation other than the Bullwagon Dolomite Member. The small dissolved-solids concentrations (698 mg/L) of the water from this well indicates that the well may be misclassified and most likely is water from either the Leona or the Standpipe aquifers instead of the Vale aquifer.

Standpipe and Arroyo Aquifers

Water samples from three wells in the Standpipe and Arroyo aquifers were analyzed for their principal chemical constituents (fig. 12). Well YB-43-32-401 in the Standpipe aquifer yields freshwater (680 mg/L dissolved-solids concentration), with the principal cations being sodium and calcium in about equal proportions; magnesium is about 50 percent less. The principal anions are bicarbonate and chloride in about equal proportions; sulfate is about 50 percent less. Well YB-43-32-402, which is about 300 ft south of the above well, is completed in the Arroyo aquifer. It yields more water, but of poorer quality. The well yields slightly saline water (1,600 mg/L dissolved-solids concentration), and the principal cations are sodium and calcium; magnesium is about 50 percent less. The principal anions are chloride and sulfate, with bicarbonate being somewhat less. The third well (YB-43-47-301) yields slightly saline water (1,500 mg/L dissolved-solids concentration), its principal cations are magnesium and calcium, and its principal anions are sulfate and chloride.

Water from the Arroyo aquifer varies from fresh to slightly saline. It has different types of water at different locations and depths. All the water is very hard. Water in all three wells exceeded the secondary maximum contaminant level for dissolved-solids concentrations, and in two wells the limits for sulfate and chloride concentrations were exceeded.

Minor and Trace Elements

Of the 30 samples analyzed for major chemical constituents, 8 also were analyzed for minor and trace elements (table 7B). The elements included arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, silver, and zinc. Two of the samples were from the Leona aquifer, four from the Leona and Choza aquifer, one from the Comanche Peak aquifer, and one from the Standpipe aquifer. Selenium was the only minor or trace element whose concentration exceeded or equaled the maximum contaminant level determined by the U.S. Environmental Protection Agency (table 4). The maximum contaminant level of 10 μg/L for selenium was exceeded in the water sample from well YB-43-37-905 (13 μg/L) and equaled in the water sample from well YB-43-38-613. Both wells produce water from the Leona and Choza aquifer and are located in the Lipan Flat area. Because of the large concentration of dissolved solids and the bad taste, water from well YB-43-37-905 is not used for human consumption. Water from well YB-43-38-613 is used for irrigation but not for domestic supply.

Manganese was the only minor or trace element to exceed the secondary maximum contaminant level (50 µg/L) set by the U.S. Environmental Protection Agency (table 4). This occurred in the water sample from well YB-43-38-214 (80 µg/L). This well also produces water from the Leona and Choza aquifer and is used for livestock purposes only. The well is downslope from a nearby byproducts-rendering plant and a cattle feedlot that could be the source of the excessive manganese.

Bacteria and Nutrients

Water samples from 49 wells in the county were analyzed for fecal-coliform and fecal-streptococci bacteria (table 7C). The same wells and springs (eight) sampled for minor and trace elements also were sampled for nutrients; these well locations and analyses also are listed in table 7C.

Fecal-coliform bacteria, which are often used as an indication of the sanitary quality of the water, are present in the intestines or feces of warm-blooded animals. In the laboratory, they are defined as all organisms that produce blue colonies within 24 hours when incubated at 44°C $\pm$ 0.2°C on M-FC medium. The concentrations are expressed as the number of colonies per 100 milliliters of sample. Fecal-coliform bacteria occurrences in water reflect the presence of fecal contamination, which also is the most likely source of pathogenic microorganisms. Because no satisfactory method is available for differentiating between fecal organisms of human and animal origin, it is necessary to consider the presence of all fecal organisms in water as an indication of recent and possible dangerous fecal pollution.

Fecal-streptococci bacteria also occur in the intestines of warm-blooded animals. In the laboratory, they are defined as all organisms that produce pink or red colonies within 48 hours at 35°C $\pm$ 1.0°C on M-endo medium. The concentrations also are expressed as the number of colonies per 100 milliliters of sample. The presence of fecal-streptococci bacteria in ground water usually indicates fecal pollution, and their absence suggests little or no recent warm-blooded animal pollution. However, two varieties of fecal-streptococci bacteria occur naturally in the environment. Therefore, fecal streptococci bacteria determinations are not used as the primary criteria for evaluation of the sanitary quality of water. Such determinations, however, are useful as a supplement to the fecal-coliform bacteria test when a more precise determination of the source of contamination is necessary.

The first group of samples tested for fecal-coliform and fecal-streptococci bacteria was taken from 25 wells in April 1983. Of the 25 samples, none were positive for fecal-coliform bacteria and 15 were positive for fecal-streptococci bacteria. The fecal-streptococci bacteria count varied from less than 1 to 29 cols./100 mL (colonies per 100 milliliters). The second group of samples tested for fecal-coliform and fecal-streptococci bacteria were taken from 29 wells and 1 spring (Anson Springs) in August 1983. Of these samples, six were from wells included in the first group of wells. Twelve of the samples tested in August 1983 were positive for fecal-coliform bacteria (one sample had tested negative in April). All well samples tested positive for fecal-streptococci bacteria (two samples had tested negative in April). The fecal-coliform bacteria count varied from less than 1 to 26 cols./100 mL, and the fecal-streptococci bacteria count varied from 1 to 400 cols./100 mL. The samples tested in August contained more fecal-coliform and fecal-streptococci bacteria.

Water from well YB-43-60-101 had the greatest number of bacteria (fecal coliform, 26 cols./100 mL and fecal streptococci, 400 cols./100 mL). This well is used for livestock and is located in the southwest corner of the county in a ranching area. It is near the ranch livestock pens, and livestock may be the contributing source of the bacteria.

Water from well YB-43-38-214 also had a high bacteria count (fecal coliform, 12 cols./100 mL and fecal streptococci, 350 cols./100 mL). This well is about 6 mi northeast of San Angelo near the Concho River in a ranching area. However, this well is near a byproducts-rendering plant and a commerical feedlot. Either area could be the source of the bacteria. The tenant reported that several years ago he became ill after drinking water from this well. Now water from the well is used only for livestock.

One other well (YB-43-32-401) tested high in bacteria (fecal coliform, 23 cols./100 mL and fecal streptococci, 150 cols./100 mL). This well is in the northeast corner of the county near the Concho County line in a plowed field. There is no apparent reason for the high bacteria count for this well.

There is concern that shallow ground water in suburban areas with a large population density and no central water or sewer systems might be affected by septic systems. Of the 48 wells tested, 18 were from suburban areas that did not have central water or sewer systems. Results obtained during this study indicate that these areas do not contain any more fecal-coliform or fecal-streptococci bacteria in the ground water than other areas. In general, the aquifers do not appear to be contaminated with bacteria; however, some individual wells or localized areas could be contaminated by nearby septic tanks.

The constituents included in the nutrient analyses included nitrate, nitrite, ammonia, and phosphorus; additional analyses also were determined for total organic nitrogen, ammonia plus total organic nitrogen, and total nitrogen. Of the eight samples collected, five had concentrations in excess of 10 mg/L total nitrate, which is the maximum contaminant level set by the U.S. Environmental Protection Agency (table 4). Most all nitrogen concentrations are in the form of nitrate. Large nitrate concentrations are known to cause infant cyanosis or "blue baby" disease (table 5).

Two of the wells (YB-43-19-402 and YB-43-28-602) where the water had acceptable concentrations of total nitrate are the same wells identified earlier as having the smallest dissolved-solids concentrations in the Leona aquifer. These wells are in the northwestern part of the county. The other well (YB-43-37-905) with an acceptable level of total nitrate concentration had the largest dissolved-solids concentration (4,800 mg/L) of the 30 samples collected for major inorganic constituents.

For the four sampled wells in the Leona and Choza aquifer, all except well YB-43-37-905 described earlier, had large nitrate concentrations. Water from well YB-43-38-214 had 30 mg/L of nitrate nitrogen and also had a relatively large bacteria count. The well is downslope from a nearby byproducts-rendering plant and cattle feedlot. The other two wells (YB-43-38-613 and YB-43-45-201) also are located in the Lipan Flat area east and southeast of San Angelo and produced water with nitrate-nitrogen concentrations of 21 and 26 mg/L, respectively.

Water samples from a well tapping the Standpipe aquifer and from Anson Springs, which discharges from the Comanche Peak aquifer, had large concentrations of nitrate nitrogen. Well YB-43-32-401 and spring YB-43-53-708 had nitrate nitrogen concentrations of 37 and 18 mg/L, respectively. Well YB-43-32-401, described earlier as having relatively large bacteria counts, is located in a field and away from any houses.

The sampling of eight wells, of which five had unacceptable concentrations of nitrate for public supplies, did not produce sufficient data to assess the magnitude of the problem in terms of the occurrence of unsuitable drinking water. However, these results indicate that further investigation may be warranted.

Pesticides

In 1983, samples from three wells were analyzed for chlorinated hydrocarbon insecticides and chlorinated hydrocarbon herbicides (table 7D). Well YB-43-28-602 is completed in the Leona aquifer and is on the north edge of the Grape Creek community just northeast of San Angelo. Wells YB-43-38-613 and YB-43-45-201 are completed in the Leona and Choza aquifers and are in the Lipan Flat area. All three wells are in a farming area or near a farming area. None of the water samples taken from the wells contained insecticides or herbicides in concentrations above detection limits.

Historical Changes

Many of the wells inventoried for this study also were inventoried in previous reports (Work Projects Administration, 1941; Willis, 1954) and by the Texas Department of Water Resources in 1969. Current (1983) and historic water-quality data from wells were compared to determine if any changes had occurred (table 7). Changes in dissolved-solids concentrations and aquifer designation are shown in figure 13. These data show the general areas where the dissolved-solids concentrations of the ground water have changed, although some isolated wells in these areas may not follow the general trend.

The specific reasons for each the increases in dissolved-solids concentrations shown in figure 13 are beyond the scope of this report and would require a more detailed study. There are isolated areas in which some wells may be affected by oil-field activity (fig. 14), but this is not believed to be the general cause for the increase in dissolved-solids concentration, or degradation, of the water quality. The probable cause of most contamination is water from the Blaine Gypsum, San Angelo Sandstone, and Choza Formation of the Permian System migrating upward and mixing with water from the Leona and Bull-

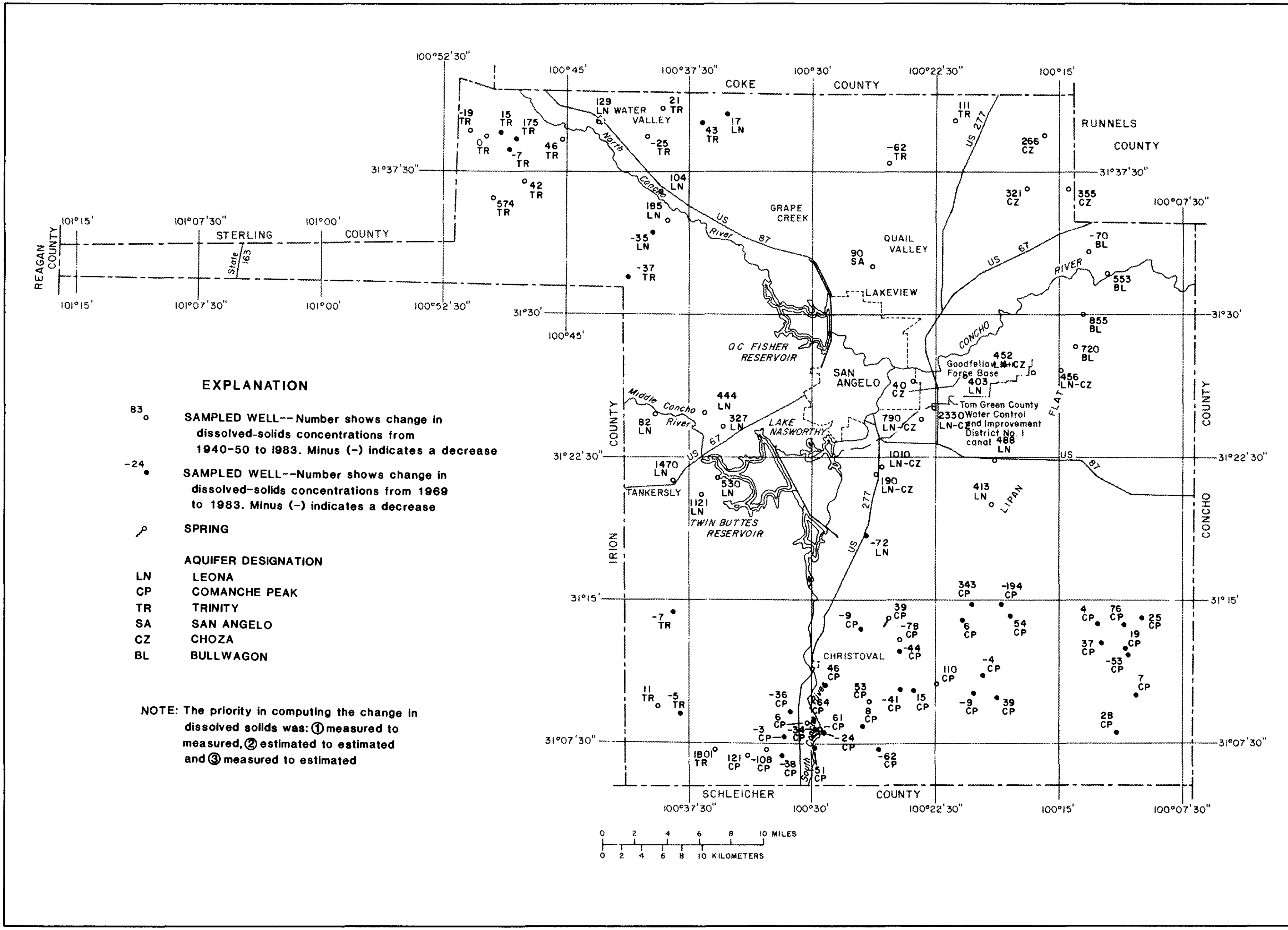

Figure 13.--Changes in dissolved-solids concentrations, by aquifer, 1940-50 to 1983 and from 1969 to 1983.

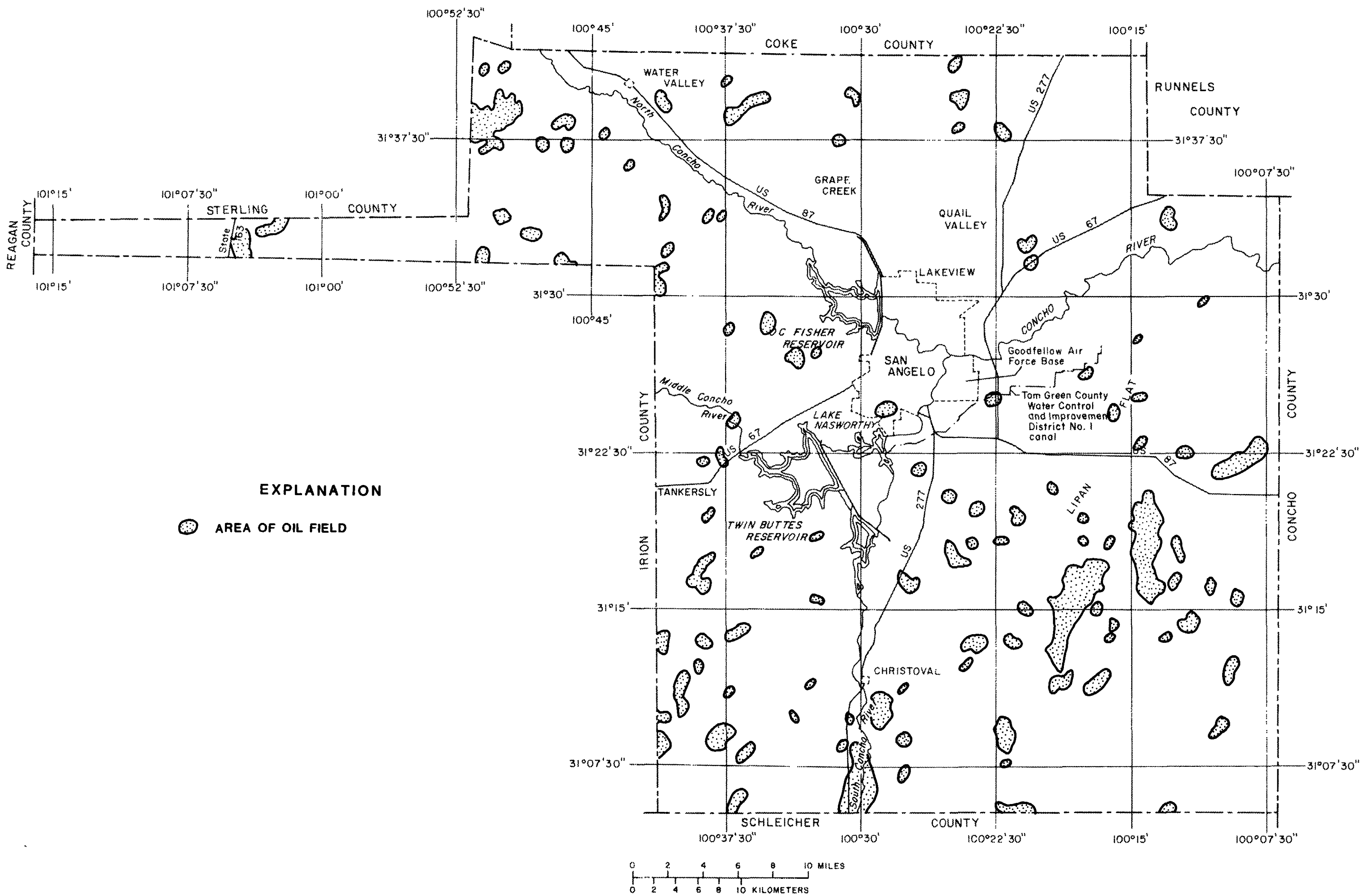

Figure 14.--Location of oil fields.

wagon aquifers and also from the deep percolation of irrigation water. Analyses from earlier reports (Work Projects Administration, 1941; Willis, 1954) indicate that water from the San Angelo aquifer contained as much as 52,400 mg/L dissolved-solids concentrations and water from the Blaine Gypsum contained as much as 9,280 mg/L dissolved-solids concentrations. In 1940, a water sample from a 112-ft deep well located about 4 mi south of Wall in the Choza aquifer contained 14,000 mg/L dissolved-solids concentrations.

From these earlier analyses, it can be concluded that there may be very poor quality ground water in certain parts of the Blaine Gypsum and the San Angelo Sandstone, which outcrop to the west and north of San Angelo. Current (1983) water-table configurations (figs. 2-4) show that the water table in these areas is higher than the water table in the Lipan Flat area. Water from the Blaine and San Angelo aquifers could move to the east and into the aquifers that supply water in the Lipan Flat area. Also in the same area, the Choza aquifer lies just under the Leona aquifer and just over the Bullwagon aquifer. Water of poor quality from the Choza aquifer could be mixing with water in the Leona and Bullwagon aquifers, which supply most of the irrigation water in the county. As the better quality water is pumped out, it could be replaced by the lesser-quality from the Choza aquifer water. No historic records are available for determining changes in bacteria, minor elements, and pesticides. A discussion on the water-quality changes in each aquifer or combined aquifers follows.

Leona and Choza Aquifers

The changes in water quality in the Leona and Choza aquifers are discussed together because many of the wells in Tom Green County draw water from both aquifers, especially most wells in the Lipan Flat area. Generally, water in the aquifers has increased in dissolved-solids concentrations since the initial sampling. This increase ranges from less than 100 to 500 mg/L with the least change being in the North Concho River valley and the Lake View areas. In the Lipan Flat area, the increase in dissolved-solids concentrations in these aquifers averaged about 400 mg/L. Water in isolated wells, however, had increases as low as 40 mg/L (well YB-43-37-602) and as high as 2,330 mg/L (well YB-43-38-402).

Of all the shallow aquifers in the county, the Leona and Choza aquifers had the greatest change in water quality. Water from well YB-43-43-303, located in the community of Tankersly in the west-central part of the county, had the largest increase in dissolved-solids concentrations (4,530 mg/L). This well was reported by Willis (1954) to be producing water from the Leona aquifer. It is possible that this well may have been deepened to also produce water from the Blaine or San Angelo aquifers, which underlie the Leona in this part of the county; this would account for the large increase in dissolved solids. Water from other wells in this area have increases in dissolved-solids concentrations from 82 to 1,121 mg/L. The average increase in dissolved-solids concentrations for this area (excluding well YB-43-43-303) is about 500 mg/L. In the farming areas, deep percolation of irrigation water is believed to be a major cause of the increased salinity.

Comanche Peak and Trinity Aquifers

Generally, no significant changes in water quality have occurred in either the Comanche Peak or Trinity aquifers since the initial sampling. However, two wells, one in the northwest and one in the southwest corner of the county, had a considerable increase in dissolved-solids concentrations. Well YB-43-26-201 had an increase in dissolved-solids concentrations of 574 mg/L (fig. 13). The well is in the northwest part of the county about 7 mi southwest of Water Valley and may be affected by oil-field activities. The well is in an area of the old Water Valley oil field, which was in operation before more stringent rules on brine disposal and well plugging were issued by the Texas Railroad Commission.

Water from well YB-43-60-101 had an increase in dissolved-solids concentrations of 1,801 mg/L. The well is in the southwest part of the county and produces water from the Trinity aquifer. The Work Projects Administration (1941) reported the depth of well YB-43-60-101 as 220 ft, and the water had 549 mg/L dissolved-solids concentration. The Willis report (1954) lists the well as being 270 ft deep and the water as having 2,270 mg/L dissolved-solids concentration. In 1983, water from this well contained 2,300 mg/L dissolved solids. The well probably was deepened to 270 ft below land surface during the drought of the 1950's and may have penetrated either the Blaine Gypsum or San Angelo Sandstone of the Permian System. This could explain the anomalous chemical characteristics of water from this well.

San Angelo Aquifer

Only one well in the San Angelo aquifer has both current (1983) and historic water-quality data. Water from the well (YB-43-29-801) had an increase of 90 mg/L in dissolved-solids concentration (1,610 mg/L in 1950 to 1,700 mg/L in 1983). This increase is about the same as the increase for the Leona aquifer in the immediate area.

Bullwagon Aquifer

The Bullwagon aquifer, the most productive aquifer of the Vale Formation, yields water of sufficient quantity to irrigation wells just west of its outcrop in the eastern part of the Lipan Flat area. Based on recent (1982-83) samples, the dissolved-solids concentrations of water in the aquifer vary from 729 to 2,560 mg/L.

The quality of water in wells north of the Concho River appears to have remained about the same. The largest dissolved-solids concentration (2,960 mg/L) was measured in water from well YB-43-31-406 during 1950 (table 6). Water from this well had no appreciable change in specific conductance (an indicator of dissolved-solids concentrations) from 1950 to 1983. The other wells completed in the Bullwagon aquifer in this area with current (1983) data had dissolved-solids concentrations of between 1,320 to 1,780 mg/L, which generally were the same as those listed in Willis (1954).

In the area south of the Concho River, however, water quality in the Bullwagon aquifer has deteriorated. Two wells in this area have historic and current (1983) water-quality data. Water from wells YB-43-31-703 and YB-43-39-104 had increases of dissolved-solids concentrations of 855 and 720 mg/L, respectively. These wells are located just south of the Concho River and indicate contamination of the aquifer, probably from infiltration of water from the Choza and Arroyo aquifers.

Standpipe and Arroyo Aquifers

Wells in the Standpipe and Arroyo aquifers having historic water-quality data could not be sampled for this study. Wells in these aquifers that were sampled for this study had water with dissolved-solids concentrations that varied from about 680 to about 2,000 mg/L. This range in dissolved solids is approximately the same as that reported by Willis (1954). Comparison of current (1983) and historic water-quality data indicates that the water quality in the aquifers has not significantly changed. One well reported to be affected by oil-field activities has been plugged and water samples could not be obtained to verify the contamination.

SUMMARY AND CONCLUSIONS

The current (1983) water levels in shallow aquifers in Tom Green County are relatively unchanged from those levels listed in previous reports (Work Projects Administration, 1941; Willis, 1954). In most wells, the changes in water levels are less than 10 ft (rise or decline), and only a few isolated wells or areas had changes over 20 ft. The largest decline in water levels was 77 ft, and the largest rise in water levels was 58 ft. Long-term hydrographs of selected wells plotted with precipitation indicate that water levels are directly related to precipitation and associated pumpage for irrigation. Current (1983) water levels probably are higher than normal because of the above normal precipitation for 1981-82. The average annual precipitation for San Angelo is 18.19 in.; in 1980 and 1981, the annual precipitation was about 30 in. each year. The shallow aquifer system in the county has a rather limited storage, but the ground-water supply in most of the county is sufficient for present needs. However, large withdrawals and/or insufficient precipitation over a long period of time could deplete the ground-water supplies and cause a decline in water levels.

Shallow ground water in Tom Green County usually is very hard (greater than 180 mg/L of calcium carbonate) and of different chemical types depending upon the aquifer and its location in the county. The concentrations of dissolved solids in the shallow aquifers range from 200 to 3,000 mg/L, the dissolved-chloride concentrations range from about 40 to 1,000 mg/L, and the dissolved-sulfate concentrations range from about 25 to 600 mg/L. Water samples from eight wells were analyzed for nitrate, and the dissolved-nitrate concentrations ranged from 2 to 37 mg/L; of these samples, five exceeded the maximum contaminant level of 10 mg/L set by the U.S. Environmental Protection Agency (1976). Of the eight water samples analyzed for minor elements, two exceeded the maximum contaminant level for selenium, and one exceeded the secondary maximum contaminant level for manganese. Water samples from three wells were analyzed for selected pesticides; no detectable limits were found for either chlorinated hydrocarbon insecticides or chlorinated-hydrocarbon herbicides.

Two groups (one in April 1983 and the other in August 1983) of ground-water samples were tested for bacteria. Of the 25 wells sampled in the first group, none were positive for fecal-coliform bacteria and 15 were positive for fecal-streptococci bacteria. The second group consisted of samples from the 29 wells and 1 spring, and 12 of these samples were positive for fecal-coliform bacteria and all 30 were positive for fecal-streptococci bacteria. Seven wells were common to both sets, and the samples tested in August contained more bacteria. Counts of fecal-coliform bacteria ranged from 0 to 26 cols./100 mL, with most counts below 5 cols./100 mL. Counts of fecal-streptococci bacteria ranged from 0 to 400 cols./100 mL. The presence of fecal-coliform and fecal-streptococci bacteria in water is only an indicator that septic pollution may be present and is not a positive check for fecal pollution.

There has been local concern that the shallow ground-water system in suburban areas with high population density and no central sewer system might be affected by septic systems. However, results obtained during this study indicate that ground water from these suburban areas contains no more bacteria than the ground-water system in rural areas. In general, the aquifers are not affected by septic pollution, however, some individual wells or localized areas could be affected by nearby septic systems.

Historic and current (1983) water-quality records were compared using dissolved-solids concentrations as a standard, to determine if any changes had occurred. In general, no significant changes in dissolved-solids concentration were found in water from Cretaceous aquifers sampled from wells in the hilly areas in the northern and southern parts of the county, and in water from the Arroyo and Bullwagon aquifers sampled from wells located north of the Concho River in the eastern part of the county (fig. 13). Generally, ground water in the remainder of the county, including in the river valleys and in the Lipan Flat area, had increases of dissolved-solids concentrations ranging from less than 100 to 500 mg/L except for three areas which are just southeast of San Angelo, just west of Twin Buttes Reservoir, and about 10 mi east of San Angelo. Ground water in these areas had increases of between 500 and 1,100 mg/L, but individual well samples showed increases of dissolved-solids concentrations of as much as 4,530 mg/L.

Although there was concern over oil-field pollution, this does not seem to be the major cause of the degradation of water quality in Tom Green County. Most of the increase in dissolved-solids concentrations in ground water in the county, especially in areas of ground-water irrigation, probably is the result of better quality water being pumped out, resulting in less desirable water from the Choza, Blaine, and San Angelo aquifers mixing with the better quality water. Deep percolation of irrigation water probably also adds to the degradation of water in parts of the county. Pollution from oil-field activities is probable in some areas in the county and in some isolated wells. No historical records are available for determining any changes in pesticides, minor elements, or bacteria.

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SUPPLEMENTAL INFORMATION

Table 2.--Cross reference of well numbers

State well number	Latitude	Longitude	From Willis (1954)	From Work Projects Administration (1941)
YB-43-18-402	314113	1005004		
YB-43-18-601	314115	1004635		
YB-43-18-602	314010	1004651		
YB-43-18-603	314008	1004635		
YB-43-18-701	313937	1005057		
YB-43-18-703	313752	1005027		
YB-43-18-704	313740	1005029		
YB-43-18-705	313749	1005054	A-7	
YB-43-18-801	313838	1004828	A-3	
YB-43-18-802	313820	1004947		
YB-43-18-803	313929	1004859		
YB-43-18-804	313908	1004758		
YB-43-18-901	313955	1004655		
YB-43-18-902	313914	1004719	A-1	
YB-43-18-903	313911	1004520	B-7	
YB-43-18-904	313825	1004653		
YB-43-18-905	313812	1004543	A-4	
YB-43-19-402	314006	1004259	B-6	215
YB-43-19-403	314013	1004311		
YB-43-19-605	314028	1003744		
YB-43-19-607	314116	1003924		230
YB-43-19-801	313929	1004010	B-5	260
YB-43-19-802	313835	1004112	B-8	
YB-43-19-803	313832	1004109		
YB-43-19-902	313931	1003743		
YB-43-20-401	314006	1003650	B-2	232
YB-43-20-403	314108	1003535		
YB-43-20-404	314040	1003534		
YB-43-20-405	314135	1003702		231
YB-43-20-701	313803	1003521		250
YB-43-20-802	313945	1003458	B-3	254
YB-43-20-803	313827	1003347		
YB-43-20-804	313741	1003306		
YB-43-20-805	313733	1003259		
YB-43-20-806	313741	1003234		
YB-43-21-801	313803	1002531	C-12	
YB-43-22-404	314014	1002126	D-1	
YB-43-22-405	314010	1002028		
YB-43-22-601	314120	1001700		
YB-43-22-602	314054	1001542		
YB-43-22-801	313920	1001953		

Table 2.--Cross reference of well numbers--Continued

State well number	Latitude	Longitude	From Willis (1954)	From Works Projects Administration (1941)
YB-43-22-802	313920	1001856		
YB-43-22-901	313935	1001554	D-8	386
YB-43-23-701	313923	1001425	D-10	387
YB-43-26-101	313602	1005057		
YB-43-26-102	313550	1005013	A-14	
YB-43-26-201	313559	1004913	A-15	
YB-43-26-202	313551	1004833		
YB-43-26-203	313644	1004808		
YB-43-26-302	313729	1004728	A-9	
YB-43-26-303	313656	1004727	A-11	
YB-43-27-201	313641	1004001	B-16	271
YB-43-27-302	313640	1003934	B-17	
YB-43-27-304	313700	1003941		
YB-43-27-501	313314	1004032	F-13	
YB-43-27-601	313414	1003948		
YB-43-27-602	313501	1003854	F-2	278
YB-43-27-801	313151	1004123		
YB-43-28-301	313505	1003224		
YB-43-28-302	313502	1003228		
YB-43-28-502	313406	1003412		
YB-43-28-503	313417	1003314		
YB-43-28-504	313415	1003311		
YB-43-28-505	323400	1003233		
YB-43-28-506	313305	1003254		
YB-43-28-507	313310	1003245		
YB-43-28-508	313315	1003244		
YB-43-28-601	313319	1003118	G-4	
YB-43-28-602	313359	1003228		
YB-43-28-603	313342	1003214		
YB-43-28-604	313310	1003220		
YB-43-29-201	313543	1002509		
YB-43-29-501	313425	1002508		
YB-43-29-502	313332	1002539		
YB-43-29-503	313312	1002511		
YB-43-29-504	313242	1002545		
YB-43-29-505	313237	1002527	G-10	
YB-43-29-506	313238	1002507		
YB-43-29-601	313447	1002414		
YB-43-29-602	313238	1002404	H-3	
YB-43-29-701	313044	1002838	G-164	22
YB-43-29-703	313121	1002857	G-103	14

Table 2.--Cross reference of well numbers--Continued

State well number	Latitude	Longitude	From Willis (1954)	From Work Projects Administration (1941)
YB-43-29-719	313103	1002831		
YB-43-29-720	313134	1002828		
YB-43-29-801	313220	1002616	G-11	
YB-43-29-802	313213	1002610		
YB-43-29-803	313133	1002614	G-13	
YB-43-29-901	313116	1002452	H-14	
YB-43-30-102	313705	1002132		
YB-43-30-103	313554	1002036		
YB-43-30-201	313517	1001836		
YB-43-30-202	313534	1001755		
YB-43-30-301	313639	1001657	D-24	390
YB-43-30-401	313440	1002152		
YB-43-30-501	313335	1001939		
YB-43-30-502	313342	1001819		
YB-43-30-503	313335	1001817		
YB-43-30-601	313311	1001645		
YB-43-30-701	313230	1002110		
YB-43-30-702	313203	1002100		
YB-43-30-703	313122	1002137		
YB-43-30-902	313210	1001544		
YB-43-30-903	313218	1001712		
YB-43-31-101	313645	1001426	D-27	392
YB-43-31-401	313408	1001358	J-1	
YB-43-31-406	313327	1001311	J-12	
YB-43-31-501	313443	1001036		
YB-43-31-502	313337	1001040		
YB-43-31-601	313407	1000836	J-4	
YB-43-31-701	313008	1001345	J-36	
YB-43-31-703	313066	1001330	J-34	
YB-43-31-714	313137	1001338	J-25	416
YB-43-31-806	313039	1001039	J-29	
YB-43-31-807	313218	1001047		
YB-43-31-808	313198	1001209	J-22	
YB-43-31-901	313038	1000902		
YB-43-32-401	313326	1000703	J-5	406
YB-43-32-402	313317	1000707		
YB-43-35-602	312621	1003753	F-27	624
YB-43-35-901	312448	1003934	F-26	627
YB-43-36-401	312620	1003611	F-29	608
YB-43-36-701	312442	1003615	K-1	
YB-43-36-702	312403	1003533	K-2	604

Table 2.--Cross reference of well numbers--Continued

State well number	Latitude	Longitude	From Willis (1954)	From Work Projects Administration (1941)
YB-43-36-703	312231	1003707		
YB-43-37-301	312947	1002410		
YB-43-37-512	312606	1002528		
YB-43-37-602	312627	1002406	H-69	
YB-43-37-703	312239	1002814		
YB-43-37-704	312238	1002811		
YB-43-37-801	312242	1002625		
YB-43-37-901	312333	1002257	M-20	
YB-43-37-902	312430	1002326	M-6	
YB-43-37-905	312352	1002423		
YB-43-37-906	312307	1002249		
YB-43-38-101	312754	1002004		
YB-43-38-214	312935	1001814		
YB-43-38-301	312836	1001628	H-40	383
YB-43-38-310	312918	1001656		
YB-43-38-401	312644	1002042	H-71	
YB-43-38-402	312509	1002217	H-106	567
YB-43-38-504	312508	1001736		
YB-43-38-613	312507	1001727		
YB-43-38-614	312657	1001646	H-75	
YB-43-38-809	312435	1001755		
YB-43-39-104	312833	1001401	J-55	
YB-43-39-114	312808	1001330		
YB-43-39-301	312925	1000802		
YB-43-39-302	312739	1000859		
YB-43-39-402	312703	1001453	J-71	
YB-43-39-601	312713	1000822		
YB-43-39-602	312519	1000831		
YB-43-39-704	312415	1001404		
YB-43-39-705	312322	1001329	N-21	
YB-43-39-706	312246	1001334		
YB-43-39-801	312309	1001141		
YB-43-39-901	312303	1000855		
YB-43-39-902	312244	1000844		
YB-43-39-903	312357	1000930		
YB-43-43-301	312202	1003743		
YB-43-43-302	312203	1003754		
YB-43-43-303	312106	1003834	K-8	638
YB-43-43-602	312746	1003740		
YB-43-44-101	312116	1003543	K-9	657
YB-43-44-102	312030	1003650	K-10	656

Table 2.--Cross reference of well numbers--Continued

State well number	Latitude	Longitude	From Willis (1954)	From Work Projects Administration (1941)
YB-43-44-302	312225	1003118		
YB-43-44-303	312011	1003118		
YB-43-44-403	311917	1003058		
YB-43-44-601	311903	1003223		
YB-43-44-701	311553	1003721		
YB-43-44-702	311537	1003720	K-19	
YB-43-45-102	312144	1002833		
YB-43-45-201	312231	1002603		
YB-43-45-202	312222	1002611		
YB-43-45-203	312200	1002553	L-4	
YB-43-45-204	312144	1002602	L-5	673
YB-43-45-205	312048	1002627		
YB-43-45-301	312144	1002455		
YB-43-45-302	312134	1002453		
YB-43-45-303	312146	1002322	M-46	
YB-43-45-304	312149	1002328		
YB-43-45-305	312158	1002326		
YB-43-45-401	311819	1002832		
YB-43-45-402	311823	1002831		
YB-43-45-403	311815	1002832		
YB-43-45-501	311830	1002645	L-13	765
YB-43-46-201	312038	1001903	M-65	
YB-43-46-204	312228	1001852	M-45	
YB-43-46-205	312230	1001751		
YB-43-46-301	312132	1001604	M-58	
YB-43-46-306	312226	1001544		
YB-43-46-307	312004	1001622		
YB-43-46-601	311933	1001608		
YB-43-46-602	311905	1001618		
YB-43-46-901	311504	1001502	M-78	744
YB-43-47-101	312223	1001358	N-24	
YB-43-47-201	312039	1001033		
YB-43-47-202	312120	1001011		
YB-43-47-301	312142	1000926		
YB-43-47-302	312206	1000902		
YB-43-47-303	312233	1000855		
YB-43-47-304	312123	1000857		
YB-43-47-305	312103	1000749		
YB-43-47-502	311844	1001013		
YB-43-47-902	311528	1000915		
YB-43-51-304	311405	1003857		

Table 2.--Cross reference of well numbers--Continued

State well number	Latitude	Longitude	From Willis (1954)	From Work Projects Administration (1941)
YB-43-51-904	310838	1003739		
YB-43-51-905	310925	1003920		
YB-43-51-906	310958	1003923		
YB-43-52-103	311432	1003727		
YB-43-52-104	311400	1003704		
YB-43-52-302	311442	1003045		
YB-43-52-303	311428	1003033		
YB-43-52-304	311453	1003132		
YB-43-52-305	311403	1003226	P-2	
YB-43-52-603				
YB-43-47-101	312223	1001358	N-24	
YB-43-47-201	312039	1001033		
YB-43-47-202	312120	1001011		
YB-43-47-301	312142	1000926		
YB-43-47-302	312206	1000902		
YB-43-47-303	312233	1000855		
YB-43-47-304	312123	1000857		
YB-43-47-305	312103	1000749		
YB-43-47-502	311844	1001013		
YB-43-47-902	311528	1000915		
YB-43-51-304	311405	1003857		
YB-43-51-904	310838	1003739		
YB-43-51-905	310925	1003920		
YB-43-51-906	310958	1003923		
YB-43-52-103	311432	1003727		
YB-43-52-104	311400	1003704		
YB-43-52-302	311441	1003045		
YB-43-52-303	311428	1003033		
YB-43-52-304	311453	1003132		
YB-43-52-305	311403	1003226	P-2	
YB-43-52-				
YB-43-52-701	310906	1003707		
YB-43-52-702	310920	1003726		
YB-43-52-802	310953	1003403		
YB-43-52-803	310953	1003335		
YB-43-52-901	310856	1003053		
YB-43-52-903	310745	1003134		
YB-43-52-904	310856	1003053		
YB-43-53-101	311357	1002750		
YB-43-53-102	311406	1002757		
YB-43-53-103	311404	1002816		

Table 2.--Cross reference of well numbers--Continued

State well number	Latitude	Longitude	From Willis (1954)	From Work Projectson, Administration (1941)
YB-43-53-201	311337	1002507	Q-1	763
YB-43-53-202	311324	1002706		
YB-43-53-301	311332	1002453		
YB-43-53-302	311252	1002432		
YB-43-53-308	311232	1002421		
YB-43-53-407	311025	1002913		
YB-43-53-409	311130	1002917		
YB-43-53-410	311003	1002926		
YB-43-53-501	311114	1002551		
YB-43-53-503	311122	1002716		
YB-43-53-601	311023	1002440		
YB-43-53-603	311141	1002449		
YB-43-53-604	311011	1002339		
YB-43-53-704	310809	1002939		
YB-43-53-705	310801	1002923		787
YB-43-53-706	310833	1002946		
YB-43-53-707	310836	1002741		
YB-43-53-708	310805	1002932	P-21	786
YB-43-53-709	310957	1002905		
YB-43-53-710	310925	1002954		
YB-43-53-711	310939	1002732		
YB-43-53-801	310847	1002550	P-18	
YB-43-53-802	310820	1002646		
YB-43-53-803	310937	1002635	P-17	788
YB-43-53-902	310939	1002240		
YB-43-54-101	311440	1002009		
YB-43-54-102	311326	1002057		
YB-43-54-201	311453	1001823		
YB-43-54-202	311350	1001746		
YB-43-54-203	311353	1001910		
YB-43-54-401	311045	1002225	Q-5	762
YB-43-54-402	311044	1002225		
YB-43-54-404	311005	1002004		
YB-43-54-501	311054	1001934		
YB-43-54-801	310958	1001836		
YB-43-55-101	311347	1001237		
YB-43-55-201	311252	1001217		
YB-43-55-202	311346	1001110		
YB-43-55-206	311404	1001140		
YB-43-55-302	311346	1001110		
YB-43-55-303	311338	1000923		

Table 2.--Cross reference of well numbers--Continued

State well number	Latitude	Longitude	From Willis (1954)	From Work Projects Administration (1941)
YB-43-55-306	311407	1000958		
YB-43-55-501	311214	1001057		
YB-43-55-502	311205	1001051		
YB-43-55-503	311126	1001035		
YB-43-55-504	311105	1001032		
YB-43-55-505	311057	1001148		
YB-43-55-506	311001	1001017		
YB-43-55-802	310835	1001145		
YB-43-55-204	310547	1004033		
YB-43-55-301	310620	1003804		
YB-43-55-302	311525	1003818		
YB-43-60-101	311656	1003548	0-6	804
YB-43-60-201	310640	1003343	P-25	803
YB-43-60-302	310638	1003143	P-27	
YB-43-60-303	310724	1003218		
YB-43-60-307	310636	1003037		
YB-43-61-102	310721	1002913		
YB-43-61-103	310650	1002940		
YB-43-61-203	310705	1002546		
YB-44-32-502	313237	1010500		

Table 3.--Records of wells, springs, and test holes

Aquifer: AR, Arroyo; BL, Bullwagon; CZ, Choza; CP, Comanche Peak; LN, Leona; SA, San Angelo; SP, Standpipe; TR, Trinity; VL, Vale.
Water level: R, indicates reported.
Use of water: D, domestic; Ind, industrial; Irr, irrigation; N, none; P, public supply; S, stock.

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-18-402	L. T. Clark	TR	--	90	2,168	08/08/82	39.3	S
601	W. M. Rawlings	LN	1969	70	2,125	08/26/82	36.4	S
602	George Sisco	LN	--	95	2,112	08/26/82	23.1	Irr
603	George Sisco	LN	--	90	2,102	08/26/82	18.8	Irr
701	L. T. Clark	TR	--	116	2,405	05/01/69	87.1	S
						08/08/82	79.7	
703	J. Johnson	TR	--	--	2,305	08/06/82	111.2	D,S
704	J. Johnson	TR	--	--	2,290	08/06/82	99.4	N
705	J. Johnson	TR	1940	160	2,340	07/25/50	47.7	S
						08/06/82	89.1	
801	George Weddell	TR	1922	116	2,190	07/21/50	80.3	S 1/ 2/
						08/22/83	53.4	
802	L. T. Clark	TR	--	152	2,330	05/02/69	142.3	S
						08/08/82	96.0	
803	L. T. Clark	TR	--	159	2,263	08/18/82	125.7	S
804	L. T. Clark	TR	--	--	2,188	05/01/69	95.7	S
						08/18/82	87.2	
901	George Sisco	LN	--	76	2,112	08/17/82	37.8	D,S
902	George Weddell	TR	--	88	2,134	07/27/50	41.9	S
						07/29/82	46.3	
903	J. O. Berry	TR	1948	160	2,146	07/20/50	66.7	
						07/28/82	66.0	D,S
904	J. E. Hall	TR	--	--	2,179	08/06/82	82.2	S
905	J. O. Berry	TR	--	180	2,250	07/06/50	146.5	S
						08/06/82	91.1	
19-402	B. Horh	LN	1900	70	2,095	02/17/38	44.9	D 2/
						09/12/40	46.7	
						06/27/50	49.5	
						08/17/82	50.8	
						08/26/83	50.5	
403	Water Valley School	LN	1974	110	2,095	08/18/82	56.0	P
605	W. B. Wilson	TR	--	135	2,325	09/03/82	102.5	S
607	J. Harper	TR	--	100	2,199	09/12/40	85.6	D,S
						08/22/69	96.6	
						08/06/74	91.6	1/ 2/
						11/10/75	78.6	
						11/11/77	82.5	
						03/30/81	81.0	
						07/28/82	75.9	
						08/26/83	83.9	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-19-801	J. Harper	TR	1915	79	2,089	09/12/40	54.0	S
						06/27/50	54.2	
						07/28/82	52.0	
802	W. H. Harris	LN	1937	66	2,072	06/27/50	42.9	
						08/17/82	42.2	N
803	J. W. White	LN	1974	115	2,072	08/17/82	43.5	D
902	W. B. Wilson	TR	--	135	2,248	08/14/69	83.2	S
						09/03/82	115.5	
20-401	W. B. Wilson	TR	--	80	2,265	12/03/40	30.0	D,S
						06/16/50	39.3	
						08/14/69	38.4	
						09/13/82	3/ 48.0	
403	W. B. Wilson	LN	--	--	2,131	09/13/82	9.4	S
404	W. B. Wilson	LN	--	--	2,131	08/14/69	45.8	S
						09/13/82	21.5	
405	W. B. Wilson	LN	--	--	2,200	09/12/40	85.6	S
						08/14/69	59.8	
						09/16/82	27.6	
701	P. S. Little	LN	--	84	2,078	10/01/40	59.8	N
						09/20/82	41.6	
802	W. B. Wilson	LN	--	134	2,099	12/03/40	40.7	S
						06/16/50	48.1	
						08/14/69	59.5	
						09/13/82	30.6	
803	Gene Krall	LN	1975	105	2,080	09/13/82	47.4	D,S
804	David Adams	TR	1973	110	2,098	09/15/82	99.1	D,S
805	Gary Brown	TR	1980	150	2,092	09/15/82	75.8	D,S
806	David Adams	TR	1973	100	2,060	09/15/82	70.0	N
21-801	Baker Estate	TR	1920	77	2,100	05/02/50	56.0	D,S
						09/02/69	68.9	
						07/27/83	56.6	
22-404	Oscar Brown	TR	1945	175	2,095	03/21/50	57.3	D,S 2/
						07/28/83	59.9	
						08/18/83	60.1	
405	Oscar Brown	SA	--	184	2,088	07/28/83	176.0	S
601	Wilson Page	CZ	--	238	2,015	04/05/83	191.5	2/
						08/18/83	187.8	
602	W. Klattenhoff	LN	1983	125	1,967	04/05/83	70.3	D,S
801	Oscar Brown	SA	1980's	160	2,005	07/28/83	81.8	N
802	Sanders	CZ	1980	112	2,000	07/28/83	31.0	D,S
901	W. Holland	CZ	--	79	1,910	02/14/41	30.0	D,S
						10/06/48	49.4	
						07/28/83	39.0	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-23-701	Milton Heinze	CZ	1930	70 70 110	1,902	02/14/41 02/21/50 07/28/83 08/18/83	54.5 64.8 68.5 68.5	D,S 2/
26-101	E. V. Hall	TR	1973	156	2,280	07/28/82	114.7	D,S
102	E. V. Hall	TR	1946	140	2,300	07/25/50 07/28/82	110.7 98.2	S
201	Weddell	TR	1949	209	2,304	07/21/50 07/28/82	121.9 95.8	S
202	E. V. Hall	TR	--	--	2,311	--	--	S
203	E. V. Hall	TR	--	100+	2,284	07/28/82	96.4	S
302	E. V. Hall	TR	--	80	2,252	07/20/50 07/28/82	64.4 56.4	S
303	E. V. Hall	TR	1918	72	2,270	07/20/50 07/28/82	60.3 61.6	S
27-201	State Sanatorium	LN	1938	75	2,014	09/11/40 02/17/71 09/15/82	17.3 36.5 21.6	P
302	State Sanatorium	LN	1938	77	2,015	07/07/50 02/17/71 09/15/82	35.1 32.8 32.4	P
304	City of Carlsbad	LN	1956	90	2,025	04/07/83	39.8	P
501	Robert Turner	TR	--	100	2,140	09/11/50 09/17/69 10/05/82	37.6 34.3 27.7	S
601	Percy Turner	LN	1947	80	2,079	09/04/69 10/05/82	52.5 45.8	S
602	Conley Estate	LN	--	82	2,020	12/05/40 06/28/50 10/05/82	53.3 42.0 30.6	S
801	Kenneth Brown	TR	1957	276	2,337	09/17/69 10/05/82 08/22/83	250 R 217.2 217.0	S 2/
28-301	Cecil Carder	LN	1978	102	2,003	09/30/82	65.0	D,S
302	Ray Bolf	LN	1973	124	1,999	09/30/82	61.5	D
502	Cary Tomberlin	LN	1956	85	1,960	03/30/83	33.0	D,Irr
503	Vernon Doss	LN	1972	100	1,974	09/29/82	49.3	D
504	Vernon Doss	LN	1972	100	1,972	09/29/82	45.5	D
505	Dave Monson	LN	1976	103	1,975	07/19/82	46.0	D,S
506	Weldon Baker	LN	1978	72	1,952	09/22/82	43.3	D
507	R. Pennington	LN	1976	100	1,955	09/22/82	46.3	D
508	E. Hinson	LN	1968	96	1,958	09/20/82	45.5	D,S

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-28-601	R. Sheffield	LN	1926	90	1,964	06/15/50	50.8	Irr 1/
						12/10/62	72.0	
						12/02/63	58.0	
						12/01/64	64.3	
						12/08/65	67.0	
						12/28/67	59.7	
						12/04/68	58.6	
						12/04/69	57.4	
						12/03/70	57.7	
						12/10/71	57.7	
						12/06/72	57.4	
						12/06/73	54.3	
						12/10/74	55.1	
						11/10/75	49.5	
						11/04/76	51.4	
						11/11/77	52.8	
						11/15/78	57.0	
						04/01/81	54.4	
						10/17/81	55.0	
						07/19/82	49.4	
602	Gary Parks	LN	1973	100	1,975	09/30/82	54.6	D
603	W. Harris	LN	1979	100	1,972	09/23/82	54.2	D
604	Clifton Mason	LN	1974	95	1,957	09/20/82	46.1	D
29-201	Bob Lerch	SA	1981	200	2,015	08/01/83	151.1	D 2/
						08/20/83	151.6	
501	W. Sparks	LN-SA	1978	195	2,000	04/04/83	156.4	D
502	R. Henson	LN-SA	--	183	2,025	07/27/83	157.2	N
503	R. Michel	LN-SA	--	146	2,025	07/27/83	139.0	D
504	V. Willis	LN-SA	1976	145	1,954	08/01/83	110.0	D,S
505	Frank Book	SA	1943	108	1,953	12/14/50	81.5	S
						08/01/83	98.4	
506	Frank Brook	SA	1982	94	1,953	08/01/83	33.7	S
601	Javan Vosburg	SA	1980	195	1,970	04/04/83	110.2	D
602	H. Eggemeyer	SA	1947	114	1,945	12/14/50	82.3	S
						08/01/83	113.2	
701	O. K. Morris	LN	1927	92	1,914	01/20/41	42.0	Irr
						10/12/43	45.4	
						12/16/43	45.4	
						01/23/46	47.9	
						12/14/50	52.6	
						04/04/52	57.7	
						01/07/53	60.6	
						01/15/54	57.7	
						12/08/55	44.5	
						01/16/57	41.1	
						12/12/57	22.5	
						12/14/60	25.0	
						12/05/62	29.4	
						12/02/63	37.4	
						12/01/64	42.4	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well comple-tion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measure-ment	Water levels: Below land-surface datum (feet)	Use of water
YB-43-29-701--Continued						12/08/65	48.8	
						12/05/66	48.2	
						12/28/67	53.1	
						12/04/68	52.8	
						12/04/69	52.7	
						01/07/71	55.0	
						12/06/72	54.2	
						12/06/73	54.0	
						12/10/74	50.3	
						11/10/75	41.7	
						11/04/76	38.7	
						11/11/77	40.0	
						11/15/78	42.1	
						10/12/81	39.7	
						07/30/82	33.4	
703	Chris Dublin	LN	1932	75	1,922	01/20/41	50.0	1/
						07/07/83	41.7	
719	Larry Kiser	LN	1972	85	1,917	08/16/82	36.7	D
720	Clayton Latham	LN	1982	88	1,920	04/04/83	35.8	D
801	F. Machann	SA	1946	99	1,946	05/02/50	54.8	S 2/
						08/01/83	47.7	D,S
						08/30/83	47.7	
802	Don Stringer	SA	1972	90	1,942	08/01/83	42.2	D,S
803	D. Burleson	SA	--	88	1,926	05/02/50	82.7	D,S
						08/01/83	53.0	
901	Curran Jones	SA	--	83	1,905	12/14/50	57.5	S
						08/01/83	42.5	
30-102	Sam Scheuber	SA	1971	--	2,073	08/07/74	154.1	S
						12/11/74	160.4	
						11/11/75	161.7	
						11/04/76	149.0	
						11/11/79	150.2	
						10/12/81	162.0	
						07/30/82	162.7	
103	Johnson Estate	SA	1975	40	1,915	09/02/82	10.3	S 2/
201	Johnson Estate	CZ	1956	80	1,890	09/02/82	43.3	S
202	Johnson Estate	LN-CZ	1936	80	1,890	09/02/82	43.2	S
301	Carl Urbante	CZ	--	80	1,902	10/02/40	58.3	D,S
						01/24/49	63.3	
						02/21/50	60.4	
						07/28/83	50.8	
401	Johnson Estate	CZ	1955	86	1955	09/02/82	77.2	S
501	Johnson Estate	CZ	1981	125	1863	09/02/82	51.7	S
502	Johnson Estate	CZ	1973	90	1830	09/02/82	15.7	S
503	H. Albert	CZ	1970	110	1820	07/23/82	19.45	D,S
601	M. L. Burner	CZ	1966	100	1785	07/23/82	5.8	
						04/05/83	7.7	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-30-701	Johnson Estate	CZ	1950	82	1,890	09/02/82	71.2	S
702	Johnson Estate	CZ	1950	80	1,850	09/02/82	45.4	S 2/
						08/29/83	51.8	
703	Johnson Estate	CZ	1970	110	1,855	07/02/82	41.3	S
902	Nelson Irvin	CZ	1960	--	1,760	09/02/82	54.4	S
903	Johnson Estate	CZ	--	60	1,765	09/02/82	12.8	S
31-101	M. S. Winston	CZ	1900	90	1,900	10/02/40	69.8	D,S
						12/15/50	67.9	
						08/28/83	63.8	
401	A. L. Douglas	BL	1950	300	1,807	01/03/51	48.6	Irr 1/
						08/30/83	43.5	
406	A. H. Smith	BL	1949	218	1,785	02/24/50	97.7	Irr
501	L. J. Jeschke	BL	1956	100	1,780	07/26/83	72.9	D,S
502	L. J. Jeschke	BL	--	100	1,780	07/26/83	95.0	S
601	S. E. Parmer	VL	--	75	1,771	02/28/50	48.2	D,S
						07/26/83	48.8	
701	J. S. Johnson	LN-BL	1943	195	1,805	02/09/50	69.2	Irr
						06/05/51	137.1	
						06/15/52	138.5	
						07/26/83	74.0	N
703	L. J. Sidel	BL	1943	182	1,807	11/10/48	71.4	Irr
						05/31/50	121.9	
						07/15/52	136.3	
						10/01/84	148.0	
714	Dickson, E. P.	LN	--	28	1,735	01/23/41	17.8	D,S 2/
						12/17/43	19.6	
						12/09/48	23.4	
						08/29/83	16.6	
806	M. Wright	BL	--	102	1,775	05/31/50	135.2	D,S
						07/26/83	134.5	
807	Orman Gabbert	LN	--	30	1,710	07/25/83	22.2	D
808	F.W. Hardgrave	BL	1951	153	1,770	01/02/51	96.2	Irr
						01/15/52	109.2	
901	William Martin	LN	1974	60	1,735	03/30/83	40.1	D,S
32-401	Schwertner	SP	--	50	1,764	01/29/41	45 R	D,S 2/
						02/24/50	42.3	
						07/27/83	42.4	
						08/29/83	42.2	
402	Schwertner	AR	1980	90	1,764	07/27/83	40.0	D,S 2/
						08/29/83	39.9	
35-602	Henry Peil	LN-TR	1933	69	2,080	02/11/40	43.9	D,S 1/ 2/
						08/22/83	47.4	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-36-901	Duncan Ranch	LN	1925	51	1,990	10/27/40	19.4	D,S
						09/15/50	20.1	
						05/17/83	21.0	
401	Homer Byrd	LN-TR	1915	100	2,050	02/10/41	56.6	D,S
						07/12/50	62.3	
						05/17/83	62.4	N
701	Merlin Hurt	LN	--	73	2,002	09/14/50	56.3	D,S
						05/17/83	55.8	
702	Gunter	LN	1920	66	1,985	08/26/40	43 R	
						09/14/50	58.8	S
						05/17/83	59.9	
703	Ethel Rape	LN	--	35	1,960	05/17/83	20.2	S
37-701	Bob Henson	LN	1970	67	1,875	06/09/83	51.0	D,S
512	Robert Allison	LN	--	40	1,822	04/13/83	13.4	Irr
602	Bessire	CZ	1945	73	1,835	10/12/48	34.6	D,S
						03/06/50	33.6	
						07/27/83	36.5	
703	Chandler	LN	1972	25	1,880	07/26/83	17.7	D
704	Chandler	SA	1974	45	1,880	07/26/83	29.2	Irr
801	W. B. Black	LN-CZ	1977	80	1,895	04/28/83	41.0	N
901	R. E. Stanford	CZ	1947	82	1,867	11/30/48	52.3	Irr
						06/30/49	44.6	
						02/20/50	45.7	
						04/27/83	36.8	
902	Ben Book	LN-CZ	1946	87	1,863	11/12/48	49.6	Irr
						06/30/49	48.6	
						06/17/83	36.4	
905	Olga Suehudec	LN-CZ	1943	90	1,876	08/30/83	34.8	Irr,S 2/
906	Robert Taylor	LN-CZ	1976	60	1,868	06/17/83	38.0	Irr
38-101	Bob Vidler	LN-CZ	1979	109	1,815	07/20/82	32.1	N
214	Johnson Estate	LN-CZ	--	60	1,770	09/02/82	34.4	S 2/
						08/29/83	31.5	
301	A. F. Schumm	LN-CZ	1928	125	1,820	01/25/41	65 R	Irr
						09/08/41	65 R	
						09/10/43	73 R	
						09/24/48	73.2	
						04/18/49	65.2	
						01/29/52	72.5	
						01/05/53	77.5	
						01/14/54	85.6	
						12/07/55	92.8	
						01/16/57	97.0	
						12/13/60	59.0	
						12/05/61	55.6	
						12/03/62	62.3	
						12/02/63	67.2	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well comple- tion	Depth of well (feet)	Altitude of land surface (feet)	Water levels		Use of water
						Date of measure- ment	Below land-surface datum (feet)	
YB-43-38-301--Continued						12/01/64	74.6	
						12/08/65	84.5	
						12/05/66	82.8	
						12/28/67	65.6	
						12/03/69	57.1	
						12/04/70	56.0	
						12/13/71	53.9	
						12/06/72	57.4	
						12/05/73	61.1	
						12/11/74	57.3	
						11/11/75	45.5	
						11/04/76	48.0	
						11/10/77	47.7	
						11/15/78	50.8	
						10/12/81	53.4	
						07/20/82	50.2	
310	Veribest Cattle Feeders	LN-CZ	--	100	1,800	09/02/82	42.3	D,S
401	Abernathy	LN	--	70	1,836	12/23/48	60 R	D,S
						07/02/49	60.4	
						02/20/50	60.6	
						07/28/83	39.9	
402	A. Mikeska	LN-CZ	1930	80	1,851	11/01/40	43.8	D,S
						12/18/43	43.1	
						12/31/48	45.1	
						07/28/83	35.4	
504	Calvin Pelzer	LN-CZ	1977	110	1,830	07/28/83	44.1	Irr
613	Calvin Pelzer	LN-CZ	1970	120	1,832	07/28/83	42.0	Irr 2/
						08/23/83	42.0	
614	Lambs	LN-CZ	1924	96	1,828	08/17/43	56.2	D,S
						12/08/48	44.9	
						07/28/83	46.8	
702	Robert Taylor	CZ	1938	63	1,867	11/11/75	26.6	N
						08/17/83	39.6	
809	Leonard Jansa	LN-CZ	1979	120	1,837	07/20/82	29.1	D
39-104	R.E. McCullough	BL	1946	103	1,810	11/05/48	70.0	Irr
						07/03/49	69.6	
						02/09/50	67.9	
						01/29/52	80.2	
						01/06/53	87.2	
						01/14/54	85.4	
						12/06/55	89.1	
						01/16/57	88.3	
						12/11/57	83.9	
						12/13/60	56.3	
						12/05/61	53.3	
						12/03/62	62.6	
						12/02/63	75.2	
						12/01/64	82.4	
						12/08/65	83.2	
						12/05/66	86.9	
						12/28/67	88.4	
						12/06/68	59.8	
						12/03/69	56.5	
						12/04/70	54.6	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-39-104--Continued						12/13/71	52.8	
						12/06/72	55.5	
						12/05/73	60.3	
						12/11/74	58.4	
						11/11/75	47.7	
						11/04/76	49.1	
						11/10/77	49.9	
						11/15/78	52.0	
						04/01/81	65.0	
						07/20/82	50.3	
						11/10/77	49.8	
						11/15/78	52.0	
						04/01/81	65.0	
						07/20/82	50.3	
114	Gregg Phinney	BL	1977	80	1,802	04/04/83	38.8	Irr
301	Ed Kellermier	SP	1980	80	1,750	04/04/83	41.0	N
302	Roy Fischer	SP	1980	140	1,755	08/09/82	22.1	N
402	Wylie Pate	LN-CZ	1943	117	1,798	08/02/43	46.3	Irr 1/
						08/30/83	54.3	
601	Billy Goetz	SP	1974	60	1,754	08/19/82	11.5	Irr
602	Roy Fischer	SP	1980	100	1,774	08/20/82	11.5	Irr
704	Alfons Holubeck	BL	1961	140	1,822	08/19/83	42.0	Irr
705	Alfons Holubeck	BL	1946	115	1,856	12/17/48	87.7	Irr
						07/01/49	71.4	
						02/15/50	89.4	
						08/19/82	73.8	
706	Paul Beatey	BL	1975	140	1,820	08/19/83	90.9	D,S
801	Walter Fuchs	SP	1973	150	1,833	08/19/82	28.3	N
901	Clyde Powell	SP	1979	100	1,811	04/04/83	14.1	Irr
902	J. E. Powell	SP	1968	80	1,820	05/06/83	28.4	D,S
903	Donald Weishuhn	SP	1980	100	1,802	08/19/82	9.7	N
43-301	Lem Mathews	LN	1957	74	1,990	05/17/83	67.2	D,S 2/
						08/24/83	67.2	
302	Lee Ranch	LN	--	--	2,000	04/15/83	67.1	S
303	R. C. Boggs	LN	1928	37	2,013	02/21/38	34.9	
						01/28/41	36.8	
						09/15/50	36.9	
						07/20/83	35.1	S
602	Ronny Reid	LN	--	66	2,022	04/15/83	40.8	S
44-101	Sutherland	LN	1920	65	1,950	08/23/40	18.0	
						09/15/50	20.8	
						05/26/83	24.4	S
102	W.T. Boys' Ranch	LN	--	85	1,965	08/23/40	33.2	S
						05/26/83	40.0	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-44-302	Chalamar Stables	SA	--	30	1,898	03/29/83 08/25/83	11.5 11.5	S 2/
303	City of San Angelo	LN	--	58	1,958	04/15/83	45.0	S
403	Joe Stewart	LN	1977	52	1,975	03/29/83	15.8	D,S 2/
601	Block	LN	--	108	1,972	04/15/83	48.2	Irr
701	Paul Martinez	LN	--	80	2,053	04/15/83 08/24/83	76.7 70.4	D,S 2/
702	Lupe Garcia	TR	--	--	2,060	09/21/50 06/03/83	32.0 42.4	S
45-102	L. W. Ducote	LN	1963	75	1,880	03/30/76 07/27/83	13.8 10.2	D,S
201	W. B. Block	LN-CZ	1978	80	1,900	04/15/83 08/23/83	42.5 42.5	D,S 2/
202	W. B. Block	LN-CZ	1983	80	1,702	04/28/83	42.8	D,S
203	Gully	LN-CZ	1928	90	1,905	04/20/50 04/28/83	55.8 50.8	D,S
204	Larry Socha	LN-CZ	1928	80	1,908	09/04/40 12/12/50 04/15/83	58.9 56.4 51.1	D,S
205	Washington Co. School Land	LN-CZ	--	--	1,918	04/20/83	65.3	S
301	H. Swartz	LN-CZ	1983	125	1,898	04/20/83	49.0	Irr
302	H. Swartz	LN-CZ	1978	120	1,901	04/28/83	53.8	D,S
303	Mrs. Kocich	LN-CZ	1922	88	1,877	03/20/50 04/20/83	62.4 38.0	D,S
304	Mrs. Kocich	LN-CZ	1983	90	1,877	04/20/83	37.8	Irr
305	Mrs. Kocich	LN-CZ	1971	120	1,875	04/20/83	38.5	Irr,D,S
401	Dick Collette	LN	1974	44	1,983	03/29/83 08/24/83	32.1 32.1	D,S 2/
402	Dick Collette	LN	1974	50	1,975	03/29/83	28.0	Irr
403	Dick Collette	LN	1974	50	1,985	03/29/83	34.0	D,S
501	Johnson Estate	LN	1937	25	1,940	02/16/38 03/20/50 04/15/83	15.0 11.0 6.8	D,S
46-201	R. V. Allison	LN	1946	128	1,888	11/23/48 04/16/49 03/31/50	91.4 90.3 86.0	Irr
204	A. J. Bean	LN	1946	117	1,862	11/19/48 12/16/50 12/03/70 07/30/82	68.9 63.2 56.7 47.8	Irr 1/

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels		Use of water
						Date of measurement	Below land-surface datum (feet)	
YB-43-46-301	Ripple Bros.	LN-BL	1949	214	1,884	04/16/49	104.5	Irr 1/
						06/30/49	99.7	
						01/29/52	122.5	
						01/07/53	131.6	
						01/15/54	131.0	
						12/07/55	133.7	
						01/17/57	134.7	
						12/12/57	106.5	
						12/13/60	67.9	
						12/05/61	63.8	
						12/03/62	84.5	
						12/02/63	121.4	
						12/01/64	135.0	
						12/08/65	132.3	
						12/05/66	134.6	
						12/27/67	134.7	
						12/05/68	78.7	
						12/04/69	85.5	
						12/03/70	82.6	
						12/10/71	92.0	
						12/06/72	98.4	
						12/05/73	92.0	
						12/11/74	90.4	
						11/11/75	62.0	
						11/04/76	65.3	
						11/10/77	56.4	
						11/15/78	68.9	
						10/17/81	71.4	
						07/20/82	62.2	
306	Wall Trading	BL	1973	130	1,867	04/06/83	50.7	N
307	Bobby Eggemeyer	BL	1978	160	1,924	05/06/83	81.5	Irr
601	Myrl Wilde	BL	1977	160	1,932	04/06/83	76.7	Irr
602	Wilbert Jost	BL	1978	150	1,946	04/06/83	86.1	
47-101	Otto Strube	BL	1948	122	1,861	12/09/48	92.3	Irr
						04/17/51	105.6	
						07/30/82	80.4	
201	J. Hunt	AR	1973	80	1,864	04/04/83	18.3	Irr
202	J. Dusek	AR	1966	100	1,846	05/06/83	33.5	Irr
301	J. K. Roberts	AR	--	100	1,845	05/06/83	57.2	Irr,S 2/
						08/17/83	43.4	
302	H. Schwertner	AR	--	100	1,836	05/06/83	39.6	D,S
303	Powell Trust	AR	1973	100	1,825	05/06/83	32.8	D,S
304	G. H. Jones	AR	1960	80	1,852	05/06/83	33.6	S
305	M. Goetz	AR	1983	100	1,855	04/04/83	31.7	D,S
502	Travis Allen	AR	1981	120	1,917	04/04/83	47.6	S
902	Mrs. D. A. Robinson	AR	1967	100	1,997	04/05/83	90.4	S

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well comple-tion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measure-ment	Water levels: Below land-surface datum (feet)	Use of water
YB-43-51-304	Mrs. C. A. Atkinson, et al	TR	1963	85	2,123	08/15/69	50.7	S
						08/07/74	39.4	
						12/07/74	15.0	
						11/02/76	23.3	
						11/13/78	31.4	
						10/09/81	30.2	
						07/02/82	30.2	
904	Herman Allen	TR	1900	240	2,360	05/13/69	174.9	S
						04/21/83	208.6	
905	Herman Allen	TR	1928	190	2,335	05/13/69	129.6	S
						04/21/83	131.2	
906	Herman Allen	TR	1957	525	2,295	05/13/69	127.4	N
						04/21/83	130.1	
52-103	Atkinson	TR	1961	47	2,152	06/03/83	31.0	D,S
104	Atkinson	TR	--	58	2,170	06/03/83	43.0	S
302	Varley	LN	1962	48	1,998	06/03/83	42.5	N
303	Varley	LN	1964	74	2,000	06/03/83	44.4	D,S
305	E. W. Jones	TR	--	108	2,070	12/13/50	45.7	D,S
603	Brook Baker	TR	1983	52	2,042	06/14/83	17.0	
						09/24/83	28.2	P
701	Herman Allen	TR	1928	190	2,358	04/21/83	72.0	N
702	Herman Allen	TR	1973	140	2,375	04/21/83	89.5	D,S
802	John McLaughlin	TR	1983	185	2,245	04/19/83	132.5	S
803	John McLaughlin	TR	1982	--	2,210	04/19/83	115.8	N
901	Bud Akins	CP	--	50	2,085	08/05/69	32.3	S
						04/20/83	31.2	
903	Bud Akins	CP	1969	86	2,148	08/05/69	32.2	D,S
						04/20/83	67.1	
53-101	Johnson Estate	CP	--	80	2,121	05/18/83	36.1	S
102	J. Hughes	CP	1974	50	2,135	05/18/83	34.5	S,D
103	J. N. Lee	CP	--	86	2,110	03/30/83	51.6	S,D
202	Johnson Estate	CP	--	78	2,140	05/18/83	72.5	S
301	Johnson Estate	CP	--	25	2,060	05/18/83	5.4	
302	Johnson Estate	CP	1956	80	2,083	05/18/83	15.7	D,S
308	Johnson Estate	CP	1955	120	2,094	08/25/69	41.2	S
						05/18/83	32.1	
407	Johnson Estate	CP	1955	165	2,108	08/25/69	57.8	S
						11/03/82	62.5	
409	Roy McCann	CP	1974	50	2,075	03/30/83	33.2	D,S

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well comple-tion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measure-ment	Water levels: Below land-surface datum (feet)	Use of water
YB-43-53-410	Dan Brown	CP	1962	79	2,051	11/03/82	24.8	D,S
501	Johnson Estate	CP	1962	200	2,235	08/25/69	182.0	S
						05/18/83	185.7	
503	Johnson Estate	CP	--	186	2,230	11/03/82	95.2	S
601	Johnson Estate	CP	--	220	2,268	08/25/69	184.8	S
						05/18/83	183.2	
603	Johnson Estate	CP	1958	180	2,191	08/25/69	118.5	S
						05/18/83	132.9	
604	Johnson Estate	CP	1950	220	2,242	05/18/83	185.0	S
704	Ford Boulware	CP	--	35	2,070	12/02/70	26.1	D,S
						03/19/71	28.3	
						06/14/83	23.1	
705	Ford Boulware	CP	--	45	2,087	11/26/40	26.4	D,S
						06/14/83	28.2	
706	Ford Boulware	CP	1962	30	2,069	08/06/69	23.4	S
						07/02/70	17.6	
						12/02/70	20.3	
						06/14/83	17.6	
707	Ford Boulware	CP	--	140	2,170	08/06/69	128.0	S
						12/02/70	117.1	
						06/14/83	126.8	
709	Dan Brown	CP	1935	52	2,074	11/03/82	26.7	D,S
710	Beck	LN	--	26	2,051	11/03/82	21.2	D,S
711	Ed Brown	CP	1950	113	2,125	11/03/82	76.8	S
801	Edith Anson Boulware	CP	--	270	2,292	12/02/48	242.5	S
						05/16/50	241.2	
						12/02/70	244.4	
						03/19/71	243.9	
						08/08/74	238.4	
						12/04/74	214.7	
						11/11/75	237.5	
						11/01/76	190.4	
						11/11/77	237.8	
						11/13/78	241.3	
						04/01/81	249.5	
						10/09/81	249.2	
						07/21/82	237.6	
						06/14/83	236.9	
802	Edith Anson Boulware	CP	--	35	2,232	08/06/69	19.6	S
						06/14/83	19.2	
803	Ed Brown	CP	1922	140	2,162	10/20/40	119.7	D,S
						11/03/82	114.4	
902	Johnson Estate	CP	1950	230	2,255	08/25/69	162.8	S
						05/18/83	111.0	
54-101	Robertson Estate	CP	1920	125	2,178	08/03/82	51.2	S
102	Johnson Estate	CP	--	--	2,210	05/18/83	130.3	D,S

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well comple- tion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measure- ment	Water levels: Below land-surface datum (feet)	Use of water
YB-43-54-202	J. D. Robertson	CP	1947	110	22206	05/13/69	105.1	S
						08/08/74	105.4	
						11/11/75	99.6	
						11/15/78	103.6	
						04/01/81	102.2	
						08/03/82	103.0	
203	Mary Bunyard	CP	1961	260	2,327	05/13/69	252.4	S
						08/03/82	250.2	
401	Johnson Estate	CP	1920	110	2,145	10/10/40	87.1	D,S
						03/20/50	73.3	
						11/04/82	78.2	
402	Johnson Estate	CP	--	100	2,138	08/26/69	71.8	D,S 2/
						11/04/82	70.4	
						08/17/83	76.0	
404	Johnson Estate	CP	--	215	2,287	08/26/69	178.4	S
						11/04/82	192.9	
501	Johnson Estate	CP	--	166	2,262	09/15/69	146.6	S
						11/04/82	160.3	
801	Johnson Estate	CP	1930	175	2,272	09/15/69	157.0	D,S
						11/04/82	170.5	
55-101	Joe Mertz	CP	1925	100	2,170	04/05/83	54.0	S
201	Lee Pfluger	CP	1956	200	2,221	04/29/69	155.7	S
						10/18/82	157.9	
202	Joe Mertz	CP	--	100	2,155	09/23/69	81.5	S
						04/05/83	76.8	
206	Joe Mertz	CP	1967	100	2,094	04/05/83	21.7	S
302	Joe Mertz	CP	--	91	2,096	12/11/67	38.9	N
						09/23/69	38.4	
						04/05/83	38.6	
306	Joe Mertz	CP	--	100	2,105	09/23/69	45.2	S
						04/05/83	44.7	
501	Lee Pfluger	CP	1956	225	2,212	04/29/69	155.8	S
						10/18/82	118.8	
502	Lee Pfluger	CP	1956	201	2,220	04/29/69	129.9	D,S 1/ 2/
						08/08/74	131.7	
						12/07/74	130.0	
						11/11/75	129.0	
						11/01/76	128.6	
						11/15/77	128.0	
						11/15/78	131.5	
						09/01/82	128.2	
						10/18/82	131.7	
						11/05/82	130.8	
						12/21/82	131.9	
						01/28/83	128.0	
						02/24/83	129.8	
						04/06/83	128.8	
						05/06/83	130.9	
						06/17/83	127.7	
						07/07/83	136.6	
						08/17/83	134.0	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels: Date of measurement	Water levels: Below land-surface datum (feet)	Use of water
YB-43-55-503	Lee Pfluger	CP	1956	219	2,268	04/29/69	170.2	S
						10/19/82	183.5	
504	Lee Pfluger	CP	1950	205	2,210	04/29/69	113.8	S
						10/19/82	132.0	
505	Lee Pfluger	CP	1956	305	2,310	04/29/69	214.0	
						10/19/82	211.8	
506	Lee Pfluger	CP	1950	225	2,207	04/29/64	113.7	S
						10/19/82	108.5	
802	Bill Upton	CP	1941	210	2,250	05/14/69	182.0	S
						08/08/74	182.6	
						12/07/74	154.8	
						11/11/75	156.8	
						11/15/77	153.9	
						10/09/81	162.9	
						08/03/82	156.1	
59-204	Duff Ranch	TR	--	335	2,475	04/23/83	301.0	S
301	Duff Ranch	TR	--	320	2,385	04/23/83	296.9	D,S
302	Duff Ranch	TR	1944	354	2,423	04/23/83	255.0	S
60-101	Walter McGregor	TR-SA	--	270	2,308	10/14/40	205.9	S 2/
						05/17/50	206.9	
						04/20/83	212.0	
						08/24/83	212.8	
201	Hinde Estate	CP	--	121	2,185	10/14/40	109.9	D,S
						05/17/50	108.5	
						04/20/83	110.0	
302	Bud Akins	CP	--	87	2,140	05/17/50	71.8	S
						08/05/69	75.1	
						04/20/83	71.3	
303	Bud Akins	CP	--	141	2,205	04/20/83	128.6	S
307	Glen Kemp	CP	1979	70	2,108	07/21/82	37.8	Irr 1/
						09/01/82	39.5	
						10/08/82	40.4	
						11/05/82	40.9	
						12/21/82	42.1	
						01/28/83	42.4	
						02/24/83	42.8	
						03/29/83	43.3	
						05/06/83	44.1	
						06/09/83	44.4	
						07/07/83	42.1	
						08/24/83	43.4	
61-102	Boulware	CP	1964	60	2,096	08/06/69	41.7	S
						12/02/70	43.5	
						03/19/71	43.7	
						06/14/83	39.0	
103	Boulware	CP	--	40	2,085	12/02/70	34.7	S
						03/19/71	34.9	
						06/14/83	27.8	

See footnotes at end of table.

Table 3.--Records of wells, springs, and test holes--Continued

Well number	Owner	Aquifer	Year of well completion	Depth of well (feet)	Altitude of land surface (feet)	Water levels		Use of water
						Date of measurement	Below land-surface datum (feet)	
YB-43-61-203	Boulware	CP	--	--	2,163	12/02/70	77.8	S
						03/19/71	78.5	
						06/14/83	73.8	
44-32-502	Ela Sugs	Tr	1957	213	2,568	09/26/67	165.9	S 2/
						08/22/83	141.6	

1/ See figures 7 and 8.
2/ See table 7.
3/ Water level measured while well pumping.

Table 4.--Summary of standards for selected water-quality constituents and properties for public water systems 1/

[µg/L, microgram per liter; mg/L, milligram per liter; °C, degree Celsius]

Constituent 2/	Maximum contaminant level 3/	Secondary maximum contaminant level 4/
	Inorganic chemicals and related properties	
pH (standard units)	--	6.5 - 8.5
Arsenic (As)	50 µg/L	--
Barium (Ba)	1,000 µg/L	--
Cadmium (Cd)	10 µg/L	--
Chloride (Cl)	--	250 mg/L
Chromium (Cr)	50 µg/L	--
Copper (Cu)	--	1,000 µg/L
Iron (Fe)	--	300 µg/L
Lead (Pb)	50 µg/L	--
Manganese (Mn)	--	50 µg/L
Mercury (Hg)	2 µg/L	--
Nitrate (as N)	10 mg/L	--
Selenium (Se)	10 µg/L	--
Silver (Ag)	50 µg/L	--
Sulfate (SO_4)	--	250 mg/L
Zinc (Zn)	--	5,000 µg/L
Dissolved solids	--	500 mg/L
Fluoride 5/		
Average of maximum daily air temperature (°C)		
12.0 and below	2.4 mg/L	--
12.1 - 14.6	2.2 mg/L	--
14.7 - 17.6	2.0 mg/L	--
17.7 - 21.4	1.8 mg/L	--
21.5 - 26.2	1.6 mg/L	--
26.3 - 32.5	1.4 mg/L	--
	Organic chemicals	
Chlorinated hydrocarbons		
Endrin	0.2 µg/L	--
Lindane	4 µg/L	--
Methoxychlor	100 µg/L	--
Toxaphene	5 µg/L	--
Chlorophenoxys		
2,4-D	100 µg/L	--
Silvex	10 µg/L	--

1/ Public water system.--A system for the provision of piped water to the public for human consumption, if such system has at least 15 service connections or regularly serves at least 25 individuals daily at least 60 days out of the year.

2/ Constituent.--Any physical, chemical, biological, or radiological substance or matter in water.

3/ Maximum contaminant level.--The maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system. Maximum contaminant levels are those levels set by the U.S. Environmental Protection Agency (1976) in the National Interim Primary Drinking Water Regulations. These regulations deal with contaminants that may have a significant direct impact on the health of the consumer and are enforceable by the U.S. Environmental Protection Agency.

4/ Secondary maximum contaminant level.--The advisable maximum level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system. Secondary maximum contaminant levels are those levels proposed by the Environmental Protection Agency (1977a) in the National Secondary Drinking Water Regulations. These regulations deal with contaminants that may not have a significant direct impact on the health of the consumer, but their presence in excessive quantities may affect the esthetic qualities of the water and may discourage the use of a drinking-water supply by the public.

5/ Fluoride.-The maximum contamination level for fluoride depends on the annual average of the maximum daily air temperatures for the location in which the public water system is situated.

Table 5.--Source and significance of selected constituents and properties commonly reported in water analyses 1/

[°C, degree Celsius; mg/L, milligram per liter; µg/L, microgram per liter]

Constituent or property	Source or cause	Significance
Specific conductance (microsiemens per centimeter at 25°C)	Specific conductance is a measure of the ability of water to transmit an electrical current and depends on the concentrations of ionized constituents dissolved in the water. Many natural waters in contact only with granite, well-leached soil, or other sparingly soluble material have a conductance of less than 50 microsiemens. The specific conductance of some brines exceeds several hundred thousand microsiemens.	The specific conductance is an indication of the degree of mineralization of a water and may be used to estimate the concentration of dissolved solids in the water.
pH (standard units)	The pH of a solution is a measure of its hydrogen ion activity. By definition, the pH of pure water at a temperature of 25°C is 7.0. Natural waters contain dissolved gases and minerals, and the pH may deviate significantly from that of pure water. Rainwater not affected significantly by atmospheric pollution generally has a pH of 5.6 due to the solution of carbon dioxide from the atmosphere. The pH range of most natural surface and ground waters is about 6.0 to 8.5. Many natural waters are slightly basic (pH >7.0) because of the prevalence of carbonates and bicarbonates, which tend to increase the pH.	The pH of a domestic or industrial water supply is significant because it may affect taste, corrosion potential, and water-treatment processes. Acidic waters may have a sour taste and cause corrosion of metals and concrete. The National Secondary Drinking Water Regulations (U.S. Environmental Protection Agency, 1977a) set a pH range of 6.5 to 8.5 as the secondary maximum contaminant level for public water systems.
Hardness as $CaCO_3$	Hardness of water is attributable to all polyvalent metals but principally to calcium and magnesium ions expressed as $CaCO_3$ (calcium carbonate). Water hardness results naturally from the solution of calcium and magnesium, both of which are widely distributed in common minerals of rocks and soils. Hardness of waters in contact with limestone commonly exceeds 200 mg/L. In waters from gypsiferous formations, a hardness of 1,000 mg/L is not uncommon.	Hardness values are used in evaluating water quality and in comparing waters. The following classification is commonly used by the Geological Survey. Hardness as $CaCO_3$ (mg/L) — Classification 0 - 60 — Soft 61 - 120 — Moderately hard 121 - 180 — Hard >180 — Very hard Excessive hardness of water for domestic use is objectionable because it causes incrustations on cooking utensils and water heaters and increased soap or detergent consumption. Excessive hardness is undesirable also in many industrial supplies. (See discussions concerning calcium and magnesium.)
Calcium (Ca)	Calcium is widely distributed in the common minerals of rocks and soils and is the principal cation in many natural freshwaters, especially those that contact deposits or soils originating from limestone, dolomite, gypsum, and gypsiferous shale. Calcium concentrations in freshwaters usually range from zero to several hundred milligrams per liter. Larger concentrations are not uncommon in waters in arid regions, especially in areas where some of the more soluble rock types are present.	Calcium contributes to the total hardness of water. Small concentrations of calcium carbonate combat corrosion of metallic pipes by forming protective coatings. Calcium in domestic water supplies is objectionable because it tends to cause incrustations on cooking utensils and water heaters and increases soap or detergent consumption in waters used for washing, bathing, and laundering. Calcium also is undesirable in some industrial water supplies, particularly in waters used by electroplating, textile, pulp and paper, and brewing industries and in water used in high-pressure boilers.

Table 5.--Source and significance of selected constituents and properties commonly reported in water analyses--Continued

Constituent or property	Source or cause	Significance
Magnesium (Mg)	Magnesium ranks eighth among the elements in order of abundance in the Earth's crust and is a common constituent in natural water. Ferromagnesian minerals in igneous rock and magnesium carbonate in carbonate rocks are two of the more important sources of magnesium in natural waters. Magnesium concentrations in freshwaters usually range from zero to several hundred milligrams per liter; but larger concentrations are not uncommon in waters associated with limestone or dolomite.	Magnesium contributes to the total hardness of water. Large concentrations of magnesium are objectionable in domestic water supplies because they can exert a cathartic and diuretic action upon unacclimated users and increase soap or detergent consumption in waters used for washing, bathing, and laundering. Magnesium also is undesirable in some industrial supplies, particularly in waters used by textile, pulp and paper, and brewing industries and in water used in high-pressure boilers.
Sodium (Na)	Sodium is an abundant and widespread constituent of many soils and rocks and is the principal cation in many natural waters associated with argillaceous sediments, marine shales, and evaporites and in sea water. Sodium salts are very soluble and once in solution tend to stay in solution. Sodium concentrations in natural waters vary from less than 1 mg/L in stream runoff from areas of greater rainfall to more than 100,000 mg/L in ground and surface waters associated with halite deposits in arid areas. In addition to natural sources of sodium, sewage, industrial effluents, oilfield brines, and deicing salts may contribute sodium to surface and ground waters.	Sodium in drinking water may impart a salty taste and may be harmful to persons suffering from cardiac, renal, and circulatory diseases and to women with toxemias of pregnancy. Sodium is objectionable in boiler feedwaters because it may cause foaming. Large sodium concentrations are toxic to most plants; and a large ratio of sodium to total cations in irrigation waters may decrease the permeability of the soil, increase the pH of the soil solution, and impair drainage.
Potassium (K)	Although potassium is only slightly less common than sodium in igneous rocks and is more abundant in sedimentary rocks, the concentration of potassium in most natural waters is much smaller than the concentration of sodium. Potassium is liberated from silicate minerals with greater difficulty than sodium and is more easily adsorbed by clay minerals and reincorporated into solid weathering products. Concentrations of potassium more than 20 mg/L are unusual in natural freshwaters, but much larger concentrations are not uncommon in brines or in water from hot springs.	Large concentrations of potassium in drinking water may impart a salty taste and act as a cathartic, but the range of potassium concentrations in most domestic supplies seldom causes these problems. Potassium is objectionable in boiler feedwaters because it may cause foaming. In irrigation water, potassium and sodium act similarly upon the soil, although potassium generally is considered less harmful than sodium.
Alkalinity (as $CaCO_3$)	Alkalinity is a measure of the capacity of a water to neutralize a strong acid, usually to a pH of 4.5, and is expressed in terms of an equivalent concentration of calcium carbonate ($CaCO_3$). Alkalinity in natural waters usually is caused by the presence of bicarbonate and carbonate ions and to a lesser extent by hydroxide and minor acid radicals such as borates, phosphates, and silicates. Carbonates and bicarbonates are common to most natural waters because of the abundance of carbon dioxide and carbonate minerals in nature. Direct contribution to alkalinity in natural waters by hydroxide is rare and usually can be attributed to contamination. The alkalinity of natural waters varies widely but rarely exceeds 400 to 500 mg/L as $CaCO_3$.	Alkaline waters may have a distinctive unpleasant taste. Alkalinity is detrimental in several industrial processes, especially those involving the production of food and carbonated or acid-fruit beverages. The alkalinity in irrigation waters in excess of alkaline earth concentrations may increase the pH of the soil solution, leach organic material and decrease permeability of the soil, and impair plant growth.

Table 5.--Source and significance of selected constituents and properties commonly reported in water analyses--Continued

Constituent or property	Source or cause	Significance
Sulfate (SO_4)	Sulfur is a minor constituent of the Earth's crust but is widely distributed as metallic sulfides in igneous and sedimentary rocks. Weathering of metallic sulfides such as pyrite by oxygenated water releases sulfate ions to the water. Sulfate also is dissolved from soils and evaporite sediments containing gypsum or anhydrite. The sulfate concentration in natural freshwaters may range from zero to several thousand milligrams per liter. Drainage from mines may add sulfate to waters by virtue of pyrite oxidation.	Sulfate in drinking water may impart a bitter taste and act as a laxative on unacclimated users. According to the National Secondary Drinking Water Regulations proposed by the U.S. Environmental Protection Agency (1977a), the secondary maximum contaminant level of sulfate for public water systems is 250 mg/L. Sulfate also is undesirable in some industrial supplies, particularly in waters used for the production of concrete, ice, sugar, and carbonated beverages and in waters used in high-pressure boilers.
Chloride (Cl)	Chloride is relatively scarce in the Earth's crust but is the predominant anion in sea water, most petroleum-associated brines, and in many natural freshwaters, particularly those associated with marine shales and evaporites. Chloride salts are very soluble and once in solution tend to stay in solution. Chloride concentrations in natural waters vary from less than 1 mg/L in stream runoff from humid areas to more than 100,000 mg/L in ground and surface waters associated with evaporites in arid areas. The discharge of human, animal, or industrial wastes and irrigation return flows may add significant quantities of chloride to surface and ground waters.	Chloride may impart a salty taste to drinking water and may accelerate the corrosion of metals used in water-supply systems. According to the National Secondary Drinking Water Regulations proposed by the U.S. Environmental Protection Agency (1977a), the secondary maximum contaminant level of chloride for public water systems is 250 mg/L. Chloride also is objectionable in some industrial supplies, particularly those used for brewing and food processing, paper and steel production, and textile processing. Chloride in irrigation waters generally is not toxic to most crops but may be injurious to citrus and stone fruits.
Fluoride (F)	Fluoride is a minor constituent of the Earth's crust. The calcium fluoride mineral fluorite is a widespread constituent of resistate sediments and igneous rocks, but its solubility in water is negligible. Fluoride commonly is associated with volcanic gases, and volcanic emanations may be important sources of fluoride in some areas. The fluoride concentration in fresh surface waters usually is less than 1 mg/L; but larger concentrations are not uncommon in salinewater from oil wells, ground water from a wide variety of geologic terranes, and water from areas affected by volcanism.	Fluoride in drinking water decreases the incidence of tooth decay when the water is consumed during the period of enamel calcification. Excessive quantities in drinking water consumed by children during the period of enamel calcification may cause a characteristic discoloration (mottling) of the teeth. According to the National Interim Primary Drinking Water Regulations established by the U.S. Environmental Protection Agency (1976) the maximum contaminant level of fluoride in drinking water varies from 1.4 to 2.4 mg/L, depending upon the annual average of the maximum daily air temperature for the area in which the water system is located. Excessive fluoride also is objectionable in water supplies for some industries, particularly in the production of food, beverages, and pharmaceutical items.
Silica (SiO_2)	Silica ranks second only to oxygen in abundance in the Earth's crust. Contact of natural waters with silica-bearing rocks and soils usually results in a concentration range of about 1 to 30 mg/L; but concentrations as large as 100 mg/L are common in waters in some areas.	Although silica in some domestic and industrial water supplies may inhibit corrosion of iron pipes by forming protective coatings, it generally is objectionable in industrial supplies, particularly in boiler feedwater, because it may form hard scale in boilers and pipes or deposit in the tubes of heaters and on steam-turbine blades.

Table 5.--Source and significance of selected constituents and properties commonly reported in water analyses--Continued

Constituent or property	Source or cause	Significance
Dissolved solids	Theoretically, dissolved solids are anhydrous residues of the dissolved substance in water. In reality, the term "dissolved solids" is defined by the method used in the determination. In most waters, the dissolved solids consist predominantly of silica, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, and sulfate with minor or trace amounts of other inorganic and organic constituents. In areas of greater precipitation and relatively insoluble rocks, waters may contain dissolved-solids concentrations of less than 25 mg/L; but saturated sodium chloride brines in other areas may contain more than 300,000 mg/L.	Dissolved-solids values are used widely in evaluating water quality and in comparing waters. The following classification, based on the concentrations of dissolved solids, commonly is used by the Geological Survey (Winslow and Kister, 1956). Classification — Dissolved-solids concentration (mg/L) Fresh — <1,000 Slightly saline — 1,000 - 3,000 Moderately saline — 3,000 - 10,000 Very saline — 10,000 - 35,000 Brine — >35,000 The National Secondary Drinking Regulations (U.S. Environmental Protection Agency, 1977a) set a dissolved-solids concentration of 500 mg/L as the secondary maximum contaminant level for public water systems. This level was set primarily on the basis of taste thresholds and potential physiological effects, particularly the laxative effect on unacclimated users. Although drinking waters containing more than 500 mg/L are undesirable, such waters are used in many areas where less mineralized supplies are not available without any obvious ill effects. Dissolved solids in industrial water supplies can cause foaming in boilers; interfere with clearness, color, or taste of many finished products; and accelerate corrosion. Uses of water for irrigation also are limited by excessive dissolved-solids concentrations. Dissolved solids in irrigation water may adversely affect plants directly by the development of high osmotic conditions in the soil solution and the presence of phytoxins in the water or indirectly by their effect on soils.
Nitrogen (N)	A considerable part of the total nitrogen of the Earth is present as nitrogen gas in the atmosphere. Small amounts of nitrogen are present in rocks, but the element is concentrated to a greater extent in soils or biological material. Nitrogen is a cyclic element and may occur in water in several forms. The forms of greatest interest in water, in order of increasing oxidation state, include organic nitrogen, ammonia nitrogen (NH_4-N), nitrite nitrogen (NO_2-N), and nitrate nitrogen (NO_3-N). These forms of nitrogen in water may be derived naturally from the leaching of rocks, soils, and decaying vegetation; from precipitation; or from biochemical conversion of one form to another. Other important sources of nitrogen in water include effluent from wastewater-treatment plants, septic tanks, and cesspools, and drainage from barnyards, feed lots, and fertilized fields. Nitrate is the most stable form of nitrogen in an oxidizing environment and is usually the dominant form of nitrogen in natural waters and in polluted waters that have undergone self-purification or aerobic treatment pro-	Concentrations of any of the forms of nitrogen in water significantly greater than the local average may suggest pollution. Nitrate and nitrite are objectionable in drinking water because of the potential risk to bottle-fed infants for methemoglobinemia, a sometimes fatal illness related to the impairment of the oxygen-carrying ability of the blood. According to the National Interim Primary Drinking Water Regulations (U.S. Environmental Protection Agency, 1976), the maximum contaminant level of nitrate (as N) in drinking water is 10 mg/L. Although a maximum contaminant level for nitrite is not specified in the drinking-water regulations, Appendix A to the regulations (U.S. Environmental Protection Agency, 1976) indicates that waters with nitrite concentrations (as N) greater than 1 mg/L should not be used for infant feeding. Excessive nitrate and nitrite concentrations are also objectionable in water supplies for some industries, particularly in waters used for the dyeing of wool and silk fabrics and for brewing.

Table 5.--Source and significance of selected constituents and properties commonly reported in water analyses--Continued

Constituent or property	Source or cause	Significance
Nitrogen (cont.)	cesses. Significant quantities of reduced nitrogen often are present in some ground waters, deep unoxygenated waters of stratified lakes and reservoirs, and waters containing partially stabilized sewage or animal wastes.	
Phosphorus (P)	Phosphorus is a major component of the mineral apatite, which is widespread in igneous rock and marine sediments. Phosphorus also is a component of household detergents, fertilizers, human and animal metabolic wastes, and other biological material. Although small concentrations of phosphorus may occur naturally in water as a result of leaching from rocks, soils, and decaying vegetation, larger concentrations are likely to occur as a result of pollution.	Phosphorus stimulates the growth of algae and other nuisance aquatic plant growth, which may impart undesirable tastes and odor to the water, become aesthetically unpleasant, alter the chemistry of the water supply, and affect water-treatment processes.
Iron (Fe)	Iron is an abundant and widespread constituent of many rocks and soils. Iron concentrations in natural waters are dependent upon several chemical equilibria processes including oxidation and reduction; precipitation and solution of hydroxides, carbonates, and sulfides; complex formation especially with organic material; and the metabolism of plants and animals. Dissolved iron concentrations in oxygenated surface waters seldom are as much as 1 mg/L. Some ground waters, unoxygenated surface waters such as deep waters of stratified lakes and reservoirs, and acidic waters resulting from discharge of industrial wastes or drainage from mines may contain considerably more iron. Corrosion of iron casings, pumps, and pipes may add iron to water pumped from wells.	Iron is an objectionable constituent in water supplies for domestic use because it may adversely affect the taste of water and beverages and stain laundered clothes and plumbing fixtures. According to the National Secondary Drinking Water Regulations proposed by the U.S. Environmental Protection Agency (1977a), the secondary maximum contamination level of iron for public water systems is 300 µg/L. Iron also is undesirable in some industrial water supplies, particularly in waters used in high-pressure boilers and those used for food processing, production of paper and chemicals, and bleaching or dyeing of textiles.

1/ Most of the material in this table has been summarized from several references. For a more throrough discussion of the source and significance of these and other water-quality properties and constituents, the reader is referred to the following additional references: American Public Health Association and others (1975); Hem (1970); McKee and Wolf (1963); National Academy of Sciences, National Academy of Engineering (1973); National Technical Advisory Committee to the Secretary of the Interior (1968); and U.S. Environmental Protection Agency (1977b).

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs

[microsiemens, microsiemens per centimeter at 25°C; mg/L, milligram per liter]

Aquifer: AR, Arroyo; BL, Bullwagon; CZ, Choza; CP, Comanche Peak; LN, Leona; SA, San Angelo; SP, Standpipe; TR, Trinity; VL, Vale

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L)	
				Estimated	Measured
YB-43-18-402	08/08/82	TR	838	514	
YB-43-18-601	08/26/82	LN	694	431	
YB-43-18-602	08/26/82	LN	688	427	
YB-43-18-603	08/26/82	LN	1,200	724	
YB-43-18-701	05/01/69	TR	409	265	
	08/08/82		375	246	
YB-43-18-703	08/06/82	TR	2,640	1,560	
YB-43-18-801	07/21/50	TR	937	571	336
	08/06/82		575	362	
	08/22/83		540	341	330
YB-43-18-802	05/02/60	TR	748	462	
	08/08/82		749	462	
1/ YB-43-18-803	05/01/69	TR	961	585	
	06/22/79		880	538	
	08/18/82		979	596	
1/ YB-43-18-804	05/01/69	TR	1,110	672	
	07/22/75		1,200	724	
	08/18/82		1,410	846	
YB-43-18-901	08/17/82	LN	1,510	904	
YB-43-18-902	07/29/82	TR	1,840	1,100	
YB-43-18-903	07/20/50	TR	783	482	386
	07/28/82		862	528	
YB-43-18-904	08/06/82	TR	1,605	959	
YB-43-18-905	08/06/82	TR	668	415	
YB-43-19-402	09/12/40	LN	--	--	629
	08/17/82		1,180	712	
	08/26/83		1,250	753	760
YB-43-19-403	08/18/82	LN	1,770	1,055	
YB-43-19-605	08/17/69	TR	554	349	
	09/03/82		537	339	
YB-43-19-607	09/12/40	TR	--	--	439
	08/22/69		740	457	
	08/06/74		764	472	
	06/22/79		682	424	
	07/28/82		752	464	

See footnote at end of table.

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L)	
				Estimated	Measured
YB-43-19-607	08/26/83	TR	778	479	460
YB-43-19-801	09/12/40	TR	--	--	373
	07/28/82		566	356	
YB-43-19-803	08/17/82	LN	742	458	
YB-43-19-902	09/03/82	TR	618	386	
YB-43-20-401	08/14/69	TR	532	337	
	07/22/75		550	347	
	06/21/79		510	324	
	09/13/82		651	406	
YB-43-20-404	08/14/69	LN	612	383	
	09/13/82		642	400	
YB-43-20-405	09/16/82	LN	644	402	
YB-43-20-802	09/13/82	LN	647	403	
YB-43-20-803	09/13/82	LN	934	570	
YB-43-20-804	09/15/82	TR	988	601	
YB-43-20-805	09/15/82	TR	790	486	
YB-43-21-801	05/02/50	TR	1,070	649	647
	09/02/69		879	538	
	07/27/83		963	587	
YB-43-22-404	03/21/50	TR	1,190	718	630
	08/18/83		1,340	805	740
YB-43-22-405	07/28/83	SA	890	544	
YB-43-22-601	08/18/83	CZ	2,160	1,281	1,800
YB-43-22-602	04/05/83	LN	1,218	734	
YB-43-22-802	07/28/83	CZ	698	433	
YB-43-22-901	10/06/48	CZ	731	452	421
	07/28/83		1,190	718	
YB-43-23-701	08/18/83	CZ	1,550	927	800
YB-43-26-101	07/28/82	TR	520	330	
YB-43-26-102	07/28/82	TR	1,246	751	
YB-43-26-201	07/21/50	TR	1,160	701	864
	07/28/82		2,150	1,275	
YB-43-26-202	07/28/82	TR	701	435	
YB-43-26-203	07/28/82	TR	747	461	
YB-43-26-302	07/28/82	TR	710	440	
YB-43-26-303	07/20/50	TR	713	442	375
	07/28/82		642	400	
YB-43-27-201	09/15/82	LN	1,050	637	
YB-43-27-302	09/07/50	LN	942	574	568
	09/15/82		1,120	678	

See footnote at end of table.

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L)	
				Estimated	Measured
YB-43-27-501	10/05/82	TR	508	323	
YB-43-27-601	09/11/69	LN	740	457	
1/	10/05/82		680	422	
YB-43-27-602	12/05/40	LN	--	--	367
	10/05/82		904	522	
YB-43-27-801	09/17/69	TR	553	349	
	08/22/83		490	312	260
YB-43-28-301	09/30/82	LN	1,210	730	
YB-43-28-302	09/30/82	LN	1,180	712	
YB-43-28-502	03/30/83	LN	2,040	1,211	
YB-43-28-503	09/29/82	LN	859	526	
YB-43-28-504	09/29/82	LN	1,240	747	
YB-43-28-508	09/20/82	LN	1,560	933	
1/ YB-43-28-601	06/15/50	LN	849	520	
YB-43-28-602	09/30/82	LN	788	485	
	08/23/83		753	465	450
YB-43-28-603	09/23/82	LN	1,036	629	
YB-43-28-604	09/20/82	LN	1,607	960	
YB-43-29-201	08/30/83	SA	2,040	1,211	
YB-43-29-501	04/04/83	LN-SA	2,460	1,450	
YB-43-29-502	07/27/83	LN-SA	3,290	1,940	
YB-43-29-503	07/27/83	LN-SA	2,980	1,760	
YB-43-29-504	08/01/83	LN-SA	1,980	1,180	
YB-43-29-505	08/01/83	SA	5,350	3,130	
YB-43-29-506	08/01/83	SA	4,110	2,410	
YB-43-29-601	04/04/83	SA	2,640	1,560	
YB-43-29-602	08/01/83	SA	3,660	2,150	
YB-43-29-701	06/25/79	LN	859	526	
YB-43-29-703	11/04/82	LN	1,330	799	
YB-43-29-719	08/16/82	LN	1,985	1,180	
YB-43-29-720	04/04/83	LN	2,160	1,280	
YB-43-29-801	05/02/50	SA	2,940	1,730	1,610
	08/30/83		3,250	1,910	1,700
YB-43-29-802	08/01/83	SA	3,830	2,250	
YB-43-29-803	08/01/83	SA	5,150	3,020	
YB-43-29-901	08/01/83	SA	7,740	4,520	
YB-43-30-102	06/26/79	SA	2,110	1,250	
	07/30/82		2,510	1,480	
YB-43-30-103	09/02/82	SA	1,780	1,060	
YB-43-30-201	09/02/82	CZ	3,500	1,060	

See footnote at end of table.

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L) Estimated	Measured
YB-43-30-202	09/02/82	LN-CZ	1,155	698	
YB-43-30-301	10/02/40	CZ	--	--	719
	07/28/83		1,750	1,040	
YB-43-30-401	09/02/82	CZ	1,280	770	
YB-43-30-501	09/02/82	CZ	3,010	1,770	
YB-43-30-502	09/02/82	CZ	3,030	1,780	
YB-43-30-503	07/23/82	CZ	3,030	1,780	
YB-43-30-601	07/23/82	CZ	3,030	1,870	
	04/05/83		3,170	1,780	
YB-43-30-701	04/02/82	CZ	2,280	1,350	
YB-43-30-702	09/02/82	CZ	1,100	666	
	08/29/83		1,210	730	680
YB-43-30-703	09/02/82	CZ	2,950	1,740	
YB-43-30-902	09/02/82	CZ	4,040	2,370	
YB-43-30-903	09/02/82	CZ	4,540	2,660	
YB-43-31-101	10/02/40	CZ	--	--	450
	08/28/83		1,340	805	
YB-43-31-401	07/30/82	BL	3,030	1,780	
YB-43-31-406	02/24/50	BL	3,460	2,030	2,960
	05/06/83		3,330	1,960	
YB-43-31-501	07/26/83	BL	2,240	1,330	
YB-43-31-502	07/26/83	BL	2,220	1,320	
YB-43-31-601	07/26/83	VL	1,156	698	
YB-43-31-703	10/18/43	BL	--	--	710
	04/19/51		1,460	875	
YB-43-31-703	10/01/84	BL	2,930	1,730	
YB-43-31-714	08/29/83	LN	3,460	2,030	2,100
YB-43-31-806	07/26/83	BL	3,460	2,030	
YB-43-31-807	07/25/83	LN	3,000	1,770	
YB-43-31-808	01/02/51	BL	1,430	857	926
	05/06/83		2,390	1,410	
YB-43-31-901	03/30/83	LN	2,030	1,210	
YB-43-32-401	08/29/83	SP	1,320	794	680
YB-43-32-402	07/27/83	AR	2,580	1,520	
	08/29/83		2,770	1,630	1,600
YB-43-35-602	09/03/82	LN-TR	1,530	915	
	08/22/83		1,580	944	930
YB-43-35-901	10/27/40	LN	--	--	558
	09/15/50		899	549	452
	05/17/83		1,040	631	

See footnote at end of table.

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L)	
				Estimated	Measured
YB-43-36-701	09/14/50	LN	835	512	455
	05/17/83		1,600	956	
YB-43-36-702	08/26/40	LN	--	--	643
	05/17/83		1,635	976	
YB-43-36-703	05/17/83	LN	2,890	1,700	
YB-43-37-301	06/09/83	LN	2,750	1,620	
YB-43-37-512	04/13/83	LN	2,190	1,300	
YB-43-37-602	10/12/48	CZ	2,630	1,550	1,520
	07/27/83		2,690	1,590	
YB-43-37-703	07/26/83	LN	2,220	1,320	
YB-43-37-704	07/26/83	SA	5,180	3,030	
YB-43-37-801	04/28/83	LN-CZ	4,760	2,790	
YB-43-37-901	04/27/83	CZ	3,010	1,770	
YB-43-37-902	11/12/48	LN-CZ	5,910	3,460	3,220
	06/17/83		7,280	4,250	
YB-43-37-905	04/26/83	LN-CZ	8,270	4,820	
	08/30/83		8,420	4,910	4,800
YB-43-37-906	06/17/83	LN-CZ	3,390	1,990	
YB-43-38-214	09/02/82	LN-CZ	4,640	2,720	
	08/29/83		2,450	1,450	1,300
1/ YB-43-38-301	09/08/41	LN-CZ	--	--	1,680
YB-43-38-310	09/02/82	LN-CZ	2,980	1,760	
YB-43-38-401	01/20/49	LN	934	570	595
	07/28/83		1,630	973	
YB-43-38-402	11/01/40	LN-CZ	--	--	1,320
	07/28/83	LN-CZ	6,250	3,650	
YB-43-38-504	07/28/83	LN-CZ	2,560	1,510	
YB-43-38-613	07/28/83	LN-CZ	2,590	1,530	
	08/23/83	LN-CZ	2,340	1,390	1,300
YB-43-38-614	12/08/48	LN-CZ	1,380	828	825
	07/28/83	LN-CZ	2,150	1,280	
YB-43-38-702	11/05/82	CZ	4,870	2,850	
YB-43-39-104	11/05/48	BL	1,210	730	727
	06/29/79	BL	1,820	1,080	
	07/20/82	BL	2,460	1,450	
YB-43-39-114	04/04/83	BL	2,200	1,300	
YB-43-39-402	07/23/43	LN-CZ	--	--	684
	08/30/83		1,910	1,140	
YB-43-39-602	08/20/82	SP	3,140	1,850	
YB-43-39-704	08/19/83	BL	3,620	2,130	

See footnote at end of table.

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L) Estimated	Measured
YB-43-39-706	08/19/83	BL	1,208	729	
YB-43-39-902	05/06/83	SP	3,040	1,790	
YB-43-43-301	05/17/83	LN	1,650	985	
	08/24/83		1,350	811	770
YB-43-43-302	04/15/83	LN	11,440	6,660	
YB-43-43-303	02/21/38	LN	--	--	2,130
	07/20/83	LN	1,090	660	
YB-43-43-602	04/15/83	LN	1,090	660	
YB-43-44-101	08/23/40		--	--	1,570
	05/26/83	LN	3,570	2,100	
YB-43-44-102	08/23/40		--	--	669
	05/26/83		3,040	1,790	
YB-43-44-302	03/29/83	SA	4,200	2,460	
	08/25/83		4,990	2,920	2,900
YB-43-44-303	04/15/83	LN	2,560	1,510	
YB-43-44-403	03/29/83	LN	4,390	2,570	
	08/25/83		2,930	1,730	2,000
YB-43-44-601	04/15/83	LN	3,170	1,870	
YB-43-44-701	04/15/83	LN	3,310	1,950	
	08/24/83		3,340	1,970	2,000
YB-43-44-702	06/03/83	TR	740	457	
YB-43-45-102	07/27/83	LN	1,145	692	
YB-43-45-201	04/15/83	LN-CZ	4,890	2,860	
	08/23/83	LN-CZ	4,520	2,650	2,600
YB-43-45-202	04/28/83	LN-CZ	4,480	2,630	
YB-43-45-203	04/20/50	LN-CZ	--	--	1,340
	04/28/83		4,010	2,350	
YB-43-45-204	09/04/40	LN-CZ	--	--	1,420
	04/15/83		2,720	1,610	
YB-43-45-301	04/20/83	LN-CZ	2,980	1,760	
YB-43-45-302	04/28/83	LN-CZ	3,700	2,170	
YB-43-45-303	04/20/83	LN-CZ	2,380	1,410	
YB-43-45-304	04/20/83	LN-CZ	2,440	1,440	
YB-43-45-305	04/20/83	LN-CZ	3,450	2,030	
YB-43-45-401	03/29/83	LN	1,660	991	
	08/24/83		1,420	852	840
YB-43-45-402	03/29/83	LN	1,875	1,120	
YB-43-45-403	03/29/83	LN	2,040	1,210	
YB-43-45-501	02/16/38	LN	--	--	564
	04/15/83		800	492	

See footnote at end of table

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

	Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L)	
					Estimated	Measured
	YB-43-46-201	09/28/50	LN	1,550	927	917
		07/30/82		2,270	1,340	
	YB-43-46-204	08/28/50	LN	1,420	852	
		07/30/82		2,270	1,340	
1/	YB-43-46-301	04/16/49	LN-BL	2,410	1,430	1,700
	YB-43-46-307	05/06/83	BL	4,360	2,560	
	YB-43-46-602	04/06/83	BL	4,270	2,500	
	YB-43-46-901	10/15/40	CP	--	--	316
		09/01/82		450	289	
	YB-43-47-202	05/06/83	AR	2,680	1,580	
	YB-43-47-301	05/06/83	AR	2,640	1,560	1,500
		08/17/83		2,310	1,570	
	YB-43-47-302	05/06/83	AR	2,800	1,650	
	YB-43-47-303	05/06/83	AR	3,470	2,040	
	YB-43-47-304	05/06/83	AR	3,160	1,860	
	YB-43-47-902	04/05/83	AR	3,270	1,920	
1/	YB-43-51-304	08/15/69	TR	902	551	
		08/07/74	TR	723	447	
		06/25/79	TR	695	431	
		07/02/82	TR	710	440	
1/	YB-43-51-904	05/13/69	TR	571	359	
		04/21/83	TR	562	354	
	YB-43-51-905	05/13/69	TR	486	310	
		04/21/83	TR	506	321	
	YB-43-52-103	06/03/83	TR	585	367	
	YB-43-52-104	06/03/83	TR	2,270	1,340	
	YB-43-52-303	06/03/83	LN	2,630	1,550	
1/	YB-43-52-304	06/03/83	LN	23,100	13,400	
	YB-43-52-603	06/14/83	TR	512	325	
		09/24/83		772	476	
	YB-43-52-701	05/13/69	TR	450	289	
	YB-43-52-702	04/21/83	TR	570	359	
	YB-43-52-802	04/19/83	TR	707	438	
1/	YB-43-52-901	08/05/69	CP	988	601	
		04/20/83		925	565	
1/	YB-43-52-903	08/05/69	CP	500	318	
		04/20/83		495	315	
	YB-43-52-904	03/18/70	CP	660	411	
		07/02/70	CP	621	388	
		06/04/83	CP	670	417	

See footnote at end of table.

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L) Estimated	Measured
YB-43-53-101	05/18/83	CP	664	413	
YB-43-53-102	05/18/83	CP	600	376	
YB-43-53-103	03/30/83	CP	660	411	
YB-43-53-201	10/10/40	CP	--	--	334
	05/18/83	CP	595	373	
YB-43-53-202	09/15/69	CP	679	422	
	05/18/83	CP	663	413	
YB-43-53-301	05/18/83	CP	662	412	
1/ YB-43-53-302	08/25/69	CP	738	456	
	07/24/75		575	362	
	05/18/83		603	378	
1/ YB-43-53-308	08/25/69	CP	709	439	
	05/18/83		633	395	
1/ YB-43-53-407	08/25/69	CP	600	376	
	11/03/82		680	422	
YB-43-53-409	03/30/83	CP	570	359	
YB-43-53-410	11/03/82	CP	750	463	
YB-43-53-501	05/18/83	CP	535	338	
YB-43-53-503	11/03/82	CP	595	373	
1/ YB-43-53-601	08/25/69	CP	541	342	
	05/18/83		470	301	
YB-43-53-603	--	CP	--	--	
1/ YB-43-53-604	08/25/69	CP	561	353	
	05/18/83		587	368	
1/ YB-43-53-704	08/06/69	CP	692	429	
	06/14/83		633	395	
1/ YB-43-53-705	08/06/69	CP	692	429	
	06/14/83		650	405	
1/ YB-43-53-706	08/06/69	CP	735	454	
	07/02/70		683	424	
	06/14/83		572	360	
YB-43-53-707	06/14/83	CP	385	251	
YB-43-53-708	08/20/40	CP	--	--	289
	08/30/83		662	412	350
YB-43-53-709	11/03/82	CP	677	421	
YB-43-53-710	11/03/82	LN	950	579	
YB-43-53-711	11/03/82	CP	485	309	
YB-43-53-801	06/25/79	CP	485	309	
	06/14/83		505	321	
1/ YB-43-53-802	08/06/69	CP	519	329	

See footnote at end of table.

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L)	
				Estimated	Measured
YB-43-53-802	06/14/83		532	337	
YB-43-53-803	10/20/40	CP	--	--	281
YB-43-53-803	11/03/82	CP	528	334	
YB-43-53-902	05/18/83	CP	668	415	
YB-43-54-101	05/13/69	CP	748	462	
	08/03/82		1,340	805	
1/ YB-43-54-102	09/15/69	CP	567	357	
	05/18/83		587	368	
1/ YB-43-54-201	05/13/69	CP	1,674	999	
	08/03/82		1,340	805	
1/ YB-43-54-202	05/13/69	CP	480	306	
	08/08/74		493	314	
	06/26/79		594	373	
	08/03/82		573	360	
YB-43-54-203	08/03/82	CP	709	439	
1/ YB-43-54-401	10/10/40	CP	--	--	275
	12/11/67		574	361	
	08/26/69		604	378	
	11/04/82		616	385	
YB-43-54-402	11/04/82	CP	683	424	
	08/17/83		686	426	400
1/ YB-43-54-404	08/26/69	CP	530	335	
	11/04/82		513	326	
1/ YB-43-54-501	09/15/69	CP	582	366	
	11/04/82		576	362	
1/ YB-43-54-801	09/15/69	CP	434	280	
	11/04/82		502	319	
1/ YB-43-55-101	09/23/69	CP	521	330	
	04/05/83		528	334	
YB-43-55-201	04/29/69	CP	508	323	
	10/18/82		572	360	
1/ YB-43-55-202	09/23/69	CP	534	338	
1/	04/05/83		665	414	
YB-43-55-206	04/05/83	CP	553	349	
1/ YB-43-55-306	09/23/69	CP	474	303	
	04/05/83		518	328	
1/ YB-43-55-501	04/29/69	CP	597	374	
YB-43-55-501	10/18/82		630	393	
1/ YB-43-55-502	04/29/69	CP	674	419	
	09/01/82		604	378	

See footnote at end of table.

Table 6.--Specific conductance and dissolved-solids concentrations of water from wells and springs--Continued

Well number	Date of sample	Aquifer	Specific conductance (microsiemens)	Dissolved solids concentration (mg/L)	
				Estimated	Measured
YB-43-55-502	12/21/82		590	370	
	04/06/83		583	366	
	08/17/83		583	366	347
YB-43-55-503	10/19/82	CP	450	289	
YB-43-55-504	10/19/82	CP	454	291	
YB-43-55-505	10/19/82	CP	500	318	
1/ YB-43-55-506	04/29/69	CP	524	332	
	10/19/82		537	339	
1/ YB-43-55-802	05/14/69	CP	448	288	
	08/03/82		496	316	
YB-43-59-204	04/23/83	TR	498	317	
YB-43-59-301	04/23/83	TR	754	465	
YB-43-59-302	04/23/83	TR	530	335	
YB-43-60-101	10/14/40	TR-SA	--	--	549
	05/17/50	TR-SA	3,870	2,270	
	04/20/83	TR-SA	3,510	2,060	
	08/24/83	TR-SA	3,670	2,160	2,300
YB-43-60-201	10/14/40	CP	--	--	272
	04/20/83		672	418	
1/ YB-43-60-302	08/05/69	CP	661	411	
	08/20/83		595	373	
YB-43-60-303	04/20/83	CP	553	349	
YB-43-60-307	09/01/82	CP	795	489	
	12/21/82		727	450	
	03/29/83		661	411	
1/ YB-43-61-102	08/06/69		710	440	
	06/14/83		623	389	
1/ YB-43-61-103	08/06/69	CP	956	582	
	06/14/83		803	494	
1/ YB-43-61-203	08/06/69	CP	627	392	
	06/14/83		520	330	
YB-44-32-502	08/22/83	TR	410	266	240

1/ Measurements made by the Texas Water Development Board.

Table 7.--Water-quality data from wells and springs

A. Major ions and physical characteristics

[MICROSIEMENS, microsiemens per centimeter at 25°C; DEG C, degree Celsius; MG/L, milligram per liter; UG/L, microgram per liter; COLS./100 ML, colonies per 100 milliliters; K, non-ideal colony count]

Aquifer: AR, Arroyo, CZ, Choza; CP, Comanche Peak; LN, Leona; SA, San Angelo; SP, Standpipe; TR, Trinity

LOCAL IDENT-I-FIER	DATE OF SAMPLE	AQUIFER	DEPTH OF WELL, TOTAL (FEET)	SPE-CIFIC CON-DUCT-ANCE (MICRO-SIEMENS)	PH (STAND-ARD UNITS)	TEMPER-ATURE (DEG C)	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)
YB-43-18-801	83-08-22	TR	116	540	7.7	20.5	290	0	81
YB-43-19-402	83-08-26	LN	100	1250	7.2	20.5	530	230	110
YB-43-19-607	83-08-26	TR	--	778	7.2	20.5	350	37	71
YB-43-22-404	83-08-18	TR	175	1340	7.3	20.5	530	230	97
YB-43-22-601	83-08-18	CZ	238	2160	7.4	21.0	1100	950	310
YB-43-23-701	83-08-18	CZ	110	1550	7.0	20.5	590	340	130
YB-43-27-801	83-08-22	TR	276	490	7.8	20.5	220	19	61
YB-43-28-602	83-08-23	LN	100	753	7.2	20.5	390	48	94
YB-43-29-201	83-08-30	SA	275	2040	7.5	21.0	280	0	46
YB-43-29-801	83-08-30	SA	99	3250	7.2	20.5	940	710	180
YB-43-30-702	83-08-29	CZ	80	1210	7.4	20.5	510	210	100
YB-43-31-714	83-08-29	LN	28	3460	7.1	20.5	1200	940	280
YB-43-32-401	83-08-29	SP	50	1320	7.4	20.5	380	150	90
YB-43-32-402	83-08-29	AR	90	2770	7.1	20.5	900	680	220
YB-43-35-602	83-08-22	LN-TR	69	1580	7.7	20.5	590	260	120
YB-43-37-905	83-08-30	LN-CZ	90	8420	7.0	20.5	2400	2200	580
YB-43-38-214	83-08-29	LN-CZ	60	2450	7.2	20.5	850	640	200
YB-43-38-613	83-08-23	LN-CZ	120	2340	7.3	20.5	830	670	200
YB-43-43-301	83-08-24	LN	74	1350	7.6	20.5	370	99	85
YB-43-44-302	83-08-25	SA	30	4990	7.1	20.5	1300	1000	270
YB-43-44-403	83-08-25	LN	52	2930	7.5	20.5	970	690	140
YB-43-44-701	83-08-24	LN	100	3340	7.3	20.5	1000	790	230
YB-43-45-201	83-08-23	LN-CZ	80	4520	7.1	20.5	1500	1300	410
YB-43-45-401	83-08-24	LN	44	1420	7.2	20.5	460	87	120
YB-43-47-301	83-08-17	AR	100	2310	7.4	21.0	1100	860	200
YB-43-53-708	83-08-30	CP	spring	662	7.3	21.0	280	17	81
YB-43-54-402	83-08-17	CP	100	686	7.3	20.0	290	10	100
YB-43-55-502	83-08-17	CP-SA	201	583	7.5	21.0	280	74	59
YB-43-60-101	83-08-24	TR-SA	270	3670	7.7	20.5	330	41	65
YB-44-32-502	83-08-22	TR	213	410	7.9	21.0	210	8	55

Table 7.--Water-quality data from wells and springs--Continued

A. Major ions and physical characteristics--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY FIELD (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)	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)
YB-43-18-801	83-08-22	21	8.4	1.3	290	13	11	.60	18	330
YB-43-19-402	83-08-26	63	65	2.6	300	190	120	.90	26	760
YB-43-19-607	83-08-26	41	36	2.9	310	81	23	1.2	18	460
YB-43-22-404	83-08-18	70	74	4.5	300	110	190	.80	14	740
YB-43-22-601	83-08-18	79	100	7.2	150	1100	61	1.2	16	1800
YB-43-23-701	83-08-18	65	76	2.6	250	93	260	.70	22	800
YB-43-27-801	83-08-22	16	7.0	1.0	200	29	8.1	1.1	12	260
YB-43-28-602	83-08-23	37	24	1.5	340	22	46	.50	22	450
YB-43-29-201	83-08-30	40	340	14	360	440	160	1.4	10	1300
YB-43-29-801	83-08-30	120	260	7.6	230	150	800	.60	23	1700
YB-43-30-702	83-08-29	62	52	4.0	300	110	150	1.0	18	680
YB-43-31-714	83-08-29	120	270	3.8	250	610	640	.90	32	2100
YB-43-32-401	83-08-29	37	120	2.6	230	140	130	.90	25	680
YB-43-32-402	83-08-29	86	240	3.1	220	420	420	.90	30	1600
YB-43-35-602	83-08-22	70	110	3.6	330	120	290	1.1	21	930
YB-43-37-905	83-08-30	230	860	6.0	170	400	2600	.50	32	4800
YB-43-38-214	83-08-29	84	120	3.6	210	150	550	1.0	21	1300
YB-43-38-613	83-08-23	81	170	3.3	160	140	590	.70	22	1300
YB-43-43-301	83-08-24	38	140	5.8	270	42	270	.80	29	770
YB-43-44-302	83-08-25	150	590	6.1	270	180	1500	1.0	43	2900
YB-43-44-403	83-08-25	150	340	8.7	280	470	650	1.4	33	2000
YB-43-44-701	83-08-24	110	330	13	240	220	930	1.1	8.6	2000
YB-43-45-201	83-08-23	120	380	5.0	200	130	1400	.40	30	2600
YB-43-45-401	83-08-24	38	130	2.8	370	93	210	.50	26	840
YB-43-47-301	83-08-17	140	100	2.5	220	580	340	.90	16	1500
YB-43-53-708	83-08-30	18	24	1.4	260	11	43	.40	15	350
YB-43-54-402	83-08-17	9.6	36	1.9	280	25	40	.20	19	400
YB-43-55-502	83-08-17	33	15	1.4	210	71	21	.70	20	350
YB-43-60-101	83-08-24	41	710	14	290	580	750	2.7	9.5	2300
YB-44-32-502	83-08-22	17	9.3	.90	200	13	12	1.1	15	240

Table 7.--Water-quality data from wells and springs--Continued

B. Minor and trace elements

LOCAL IDENT-I-FIER	DATE OF SAMPLE	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)
YB-43-19-402	83-08-26	1	33	<1	<10	7	19	2	<1
YB-43-28-602	83-08-23	2	260	<1	<10	9	20	<1	2
YB-43-32-401	83-08-29	3	34	1	<10	26	7	2	5
YB-43-37-905	83-08-30	<1	<100	1	10	13	90	2	20
YB-43-38-214	83-08-29	<1	100	<1	<10	5	20	11	80
YB-43-38-613	83-08-23	2	100	<1	<10	3	70	2	10
YB-43-45-201	83-08-23	1	200	<1	<10	11	110	4	20
YB-43-53-708	83-08-30	1	180	<1	<10	<1	7	2	<1

LOCAL IDENT-I-FIER	DATE OF SAMPLE	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	ZINC, DIS-SOLVED (UG/L AS ZN)
YB-43-19-402	83-08-26	.1	3	<1	30
YB-43-28-602	83-08-23	<.1	2	<1	45
YB-43-32-401	83-08-29	.3	8	<1	70
YB-43-37-905	83-08-30	.2	13	<1	220
YB-43-38-214	83-08-29	<.1	5	<1	60
YB-43-38-613	83-08-23	.1	10	<1	10
YB-43-45-201	83-08-23	.2	4	<1	40
YB-43-53-708	83-08-30	<.1	<1	<1	6

Table 7.-- Water-quality data from wells and springs--Continued

C. Bacteria and nutrients

LOCAL IDENT- I- FIER	DATE OF SAMPLE	COLI- FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	STREP- TOCOCCI FECAL, KF AGAR (COLS./ 100 ML)	NITRO- GEN, NITRATE TOTAL (MG/L AS N)	NITRO- GEN, NITRITE TOTAL (MG/L AS N)	NITRO- GEN, AMMONIA TOTAL (MG/L AS N)	NITRO- GEN, ORGANIC TOTAL (MG/L AS N)	NITRO- GEN,AM- MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO- GEN, TOTAL (MG/L AS N)	PHOS- PHORUS, TOTAL (MG/L AS P)
YB-43-18-801	83-08-22	<1	K11	--	--	--	--	--	--	--
YB-43-19-402	83-04-07	<1	<1	--	--	--	--	--	--	--
	83-08-26	<1	24	3.3	<.020	.100	.60	.70	4.0	<.010
YB-43-19-607	83-08-26	<1	K7	--	--	--	--	--	--	--
YB-43-22-404	83-08-18	K4	K3	--	--	--	--	--	--	--
YB-43-22-601	83-08-18	K10	K2	--	--	--	--	--	--	--
YB-43-22-602	83-04-05	<1	K18	--	--	--	--	--	--	--
YB-43-23-701	83-08-18	<1	K5	--	--	--	--	--	--	--
YB-43-27-304	83-04-07	<1	K5	--	--	--	--	--	--	--
YB-43-27-801	83-08-22	<1	K4	--	--	--	--	--	--	--
YB-43-28-301	83-04-07	<1	<1	--	--	--	--	--	--	--
YB-43-28-502	83-04-07	<1	<1	--	--	--	--	--	--	--
YB-43-28-602	83-04-07	<1	K1	--	--	--	--	--	--	--
	83-08-23	<1	K12	4.6	<.020	.050	.65	.70	5.3	<.010
YB-43-28-603	83-04-07	<1	<1	--	--	--	--	--	--	--
YB-43-28-604	83-04-07	<1	<1	--	--	--	--	--	--	--
YB-43-29-201	83-08-30	<1	K15	--	--	--	--	--	--	--
YB-43-29-501	83-04-04	<1	20	--	--	--	--	--	--	--
YB-43-29-601	83-04-04	<1	<1	--	--	--	--	--	--	--
YB-43-29-719	83-04-05	<1	<1	--	--	--	--	--	--	--
YB-43-29-720	83-04-04	<1	K10	--	--	--	--	--	--	--
YB-43-29-801	83-08-30	<1	K19	--	--	--	--	--	--	--
YB-43-30-601	83-04-05	<1	K5	--	--	--	--	--	--	--
YB-43-30-702	83-08-29	K3	K4	--	--	--	--	--	--	--
YB-43-31-714	83-08-29	<1	K4	--	--	--	--	--	--	--
YB-43-31-901	83-04-07	<1	<1	--	--	--	--	--	--	--
YB-43-32-401	83-08-29	23	150	37	<.020	<.010	--	1.3	38	.020
YB-43-32-402	83-08-29	<1	K7	--	--	--	--	--	--	--
YB-43-35-602	83-04-05	<1	K12	--	--	--	--	--	--	--
	83-08-22	<1	K17	--	--	--	--	--	--	--
YB-43-37-905	83-08-30	K1	100	2.2	<.020	.020	.68	.70	2.9	.030
YB-43-38-214	83-08-29	K12	350	30	.090	1.20	1.7	2.9	33	.050
YB-43-38-613	83-08-23	<1	K9	21	<.020	.030	.47	.50	22	<.010
YB-43-39-114	83-04-04	<1	K1	--	--	--	--	--	--	--
YB-43-39-402	83-04-06	<1	<1	--	--	--	--	--	--	--

Table 7.-- Water-quality data from wells and springs--Continued

C. Bacteria and nutrients--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS./ 100 ML)	NITRO-GEN, NITRATE TOTAL (MG/L AS N)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN, ORGANIC TOTAL (MG/L AS N)	NITRO-GEN,AM-MONIA + ORGANIC TOTAL (MG/L AS N)	NITRO-GEN, TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)
YB-43-39-704	83-04-04	<1	29	--	--	--	--	--	--	--
YB-43-43-301	83-08-24	<1	21	--	--	--	--	--	--	--
YB-43-44-302	83-04-08	<1	K1	--	--	--	--	--	--	--
	83-08-25	<1	K7	--	--	--	--	--	--	--
YB-43-44-403	83-04-08	<1	K9	--	--	--	--	--	--	--
	83-08-25	<1	K12	--	--	--	--	--	--	--
YB-43-44-701	83-08-24	<1	K4	--	--	--	--	--	--	--
YB-43-45-201	83-08-23	<1	K19	26	<.020	.110	.59	.70	27	<.010
YB-43-45-401	83-08-24	K1	43	--	--	--	--	--	--	--
YB-43-45-402	83-04-08	<1	K6	--	--	--	--	--	--	--
YB-43-47-301	83-08-17	K4	42	--	--	--	--	--	--	--
YB-43-53-103	83-04-08	<1	K1	--	--	--	--	--	--	--
YB-43-53-409	83-04-08	<1	K4	--	--	--	--	--	--	--
YB-43-53-708	83-08-30	<1	K13	18	<.020	<.010	--	1.5	20	.020
YB-43-54-402	83-08-17	K1	230	--	--	--	--	--	--	--
YB-43-55-502	83-04-06	<1	<1	--	--	--	--	--	--	--
	83-08-17	K2	42	--	--	--	--	--	--	--
YB-43-60-101	83-08-24	26	400	--	--	--	--	--	--	--
YB-43-60-307	83-04-08	<1	K1	--	--	--	--	--	--	--
YB-44-32-502	83-08-22	K1	K5	--	--	--	--	--	--	--

Table 7.--Water-quality data from wells and springs--Continued

D. Pesticides

LOCAL IDENT-I-FIER	DATE OF SAMPLE	DEPTH OF WELL, TOTAL (FEET)	PCB, TOTAL (UG/L)	NAPH-THA-LENES, POLY-CHLOR. TOTAL (UG/L)	ALDRIN, TOTAL (UG/L)	CHLOR-DANE, TOTAL (UG/L)	DDD, TOTAL (UG/L)	DDE, TOTAL (UG/L)	DDT, TOTAL (UG/L)
YB-43-28-602	83-08-23	100	<.1	<.10	<.01	<.1	<.01	<.01	<.01
YB-43-38-613	83-08-23	120	<.1	<.10	<.01	<.1	<.01	<.01	<.01
YB-43-45-201	83-08-23	80.00	<.1	<.10	<.01	<.1	<.01	<.01	<.01

LOCAL IDENT-I-FIER	DATE OF SAMPLE	DI-AZINON, TOTAL (UG/L)	DI-ELDRIN TOTAL (UG/L)	ENDO-SULFAN, TOTAL (UG/L)	ENDRIN, TOTAL (UG/L)	ETHION, TOTAL (UG/L)	HEPTA-CHLOR, TOTAL (UG/L)	HEPTA-CHLOR EPOXIDE TOTAL (UG/L)	LINDANE TOTAL (UG/L)	MALA-THION, TOTAL (UG/L)
YB-43-28-602	83-08-23	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
YB-43-38-613	83-08-23	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
YB-43-45-201	83-08-23	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01

LOCAL IDENT-I-FIER	DATE OF SAMPLE	METH-OXY-CHLOR, TOTAL (UG/L)	METHYL PARA-THION, TOTAL (UG/L)	METHYL TRI-THION, TOTAL (UG/L)	MIREX, TOTAL (UG/L)	PARA-THION, TOTAL (UG/L)	PER-THANE TOTAL (UG/L)	TOX-APHENE, TOTAL (UG/L)	TOTAL TRI-THION (UG/L)
YB-43-28-602	83-08-23	<.01	<.01	<.01	<.01	<.01	<.1	<1	<.01
YB-43-38-613	83-08-23	<.01	<.01	<.01	<.01	<.01	<.1	<1	<.01
YB-43-45-201	83-08-23	<.01	<.01	<.01	<.01	<.01	<.1	<1	<.01

LOCAL IDENT-I-FIER	DATE OF SAMPLE	2,4-D, TOTAL (UG/L)	2,4-DP TOTAL (UG/L)	2,4,5-T TOTAL (UG/L)	SILVEX, TOTAL (UG/L)
YB-43-28-602	83-08-23	<.01	<.01	<.01	<.01
YB-43-38-613	83-08-23	<.01	<.01	<.01	<.01
YB-43-45-201	83-08-23	<.01	<.01	<.01	<.01