

GROUND-WATER QUALITY IN THE LOMPOC PLAIN, SANTA BARBARA COUNTY, CALIFORNIA, 1983

By Charles Berenbrock

U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

For readers who prefer to use metric (International System) units rather than inch-pound units, the conversion factors for the terms used in this report are listed below.

<u>Multiply inch-pound unit</u>	<u>By</u>	<u>To obtain metric unit</u>
acres	0.4047	square hectometers
feet	0.3048	meters
gallons	0.003785	cubic meters
gallons per day (gal/d)	0.003785	cubic meters per day
gallons per minute (gal/min)	0.06308	liters per second
inches	25.4	millimeters
miles	1.609	kilometers

Other abbreviation used:
mg/d - milligrams per day

Air temperature is given in degrees Fahrenheit (°F), which can be converted to degrees Celsius (°C) by the following equation:

$$\text{Temp. } ^\circ\text{C} = (\text{temp. } ^\circ\text{F} - 32) / 1.8$$

Chemical concentration is given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the solute mass per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is about the same as for concentrations in parts per million.

Chemical concentration in terms of ionic interacting values is given in milliequivalents per liter (meq/L). Milliequivalents per liter values, which are numerically equal to equivalents per million, may be converted to milligrams per liter by multiplying milliequivalents per liter by the equivalent weight (weight of the ion divided by the ionic charge).

Specific electrical conductance is given in microsiemens per centimeter (µS/cm) at 25 degrees Celsius. Microsiemens per centimeter values are numerically equal to micromhos per centimeter values.

ALTITUDE DATUM

"Sea level" in this report refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

This report summarizes the results of a comprehensive study of ground-water quality in the Lompoc plain in western Santa Barbara County. Water-quality characteristics in 1983 are described, and changes in water quality since the last comprehensive study in the early 1970's are documented.

Ground water is the main source of water in the Lompoc plain. The younger alluvium is the major aquifer and consists predominantly of unconsolidated deposits of sand and gravel. The younger alluvium is as much as 180 feet thick and is divided into an upper member and a lower member throughout most of the plain. The lower member is the main water-bearing zone in the Lompoc plain.

Long-term ground-water levels in most of the plain have not changed significantly since the 1940's. A seasonal water-level decline of about 15 feet in 1982 in the central part of the plain may be attributed to nearby military and agricultural pumping.

Ground-water quality in the plain in 1983 tended to deteriorate from east to west. Dissolved-solids concentrations throughout the plain exceeded the U.S. Environmental Protection Agency secondary maximum contaminant level of 500 milligrams per liter for drinking water; in most of the plain, concentrations exceeded 1,000 milligrams per liter. In samples from some wells, concentrations of one or more of the following constituents--sodium, chloride, nitrate, and iron--exceeded primary or secondary maximum contaminant levels for drinking water. Concentrations of constituents in some samples also exceeded recommended levels for irrigation water. The predominant ions generally were calcium, magnesium, sulfate, and bicarbonate--except in the western part, where sodium and chloride were the predominant dissolved ions.

From 1972 to 1983, dissolved-solids concentrations in the main water-bearing zone generally decreased in the central part of the plain but increased throughout most of the study area. The largest increases, greater than 1,000 milligrams per liter, were in the extreme western part of the plain.

1.0 INTRODUCTION

1.1 Purpose and Scope, and Acknowledgments

GROUND-WATER QUALITY IN THE LOMPOC PLAIN IS DOCUMENTED AND EVALUATED

This report documents ground-water conditions in the Lompoc plain and evaluates changes in ground-water quality.

Ground water is the main source of water for municipal, irrigation, and industrial supplies in the Lompoc plain. Salts from the oxidation of minerals in the soil and from streamflows, recycled irrigation waters, and effluents from wastewater-treatment facilities eventually enter the ground-water system. Miller (1976) noted that ground-water quality in the plain had deteriorated during the past several decades as a result of increasing salinity. There is concern about adverse effects of high salinity on crops and on human health.

This report, prepared in cooperation with Vandenberg Air Force Base, documents ground-water conditions and evaluates changes in ground-water quality from 1972 to 1983 in the main water-bearing zone of the Lompoc plain, the lower member of the younger alluvium.

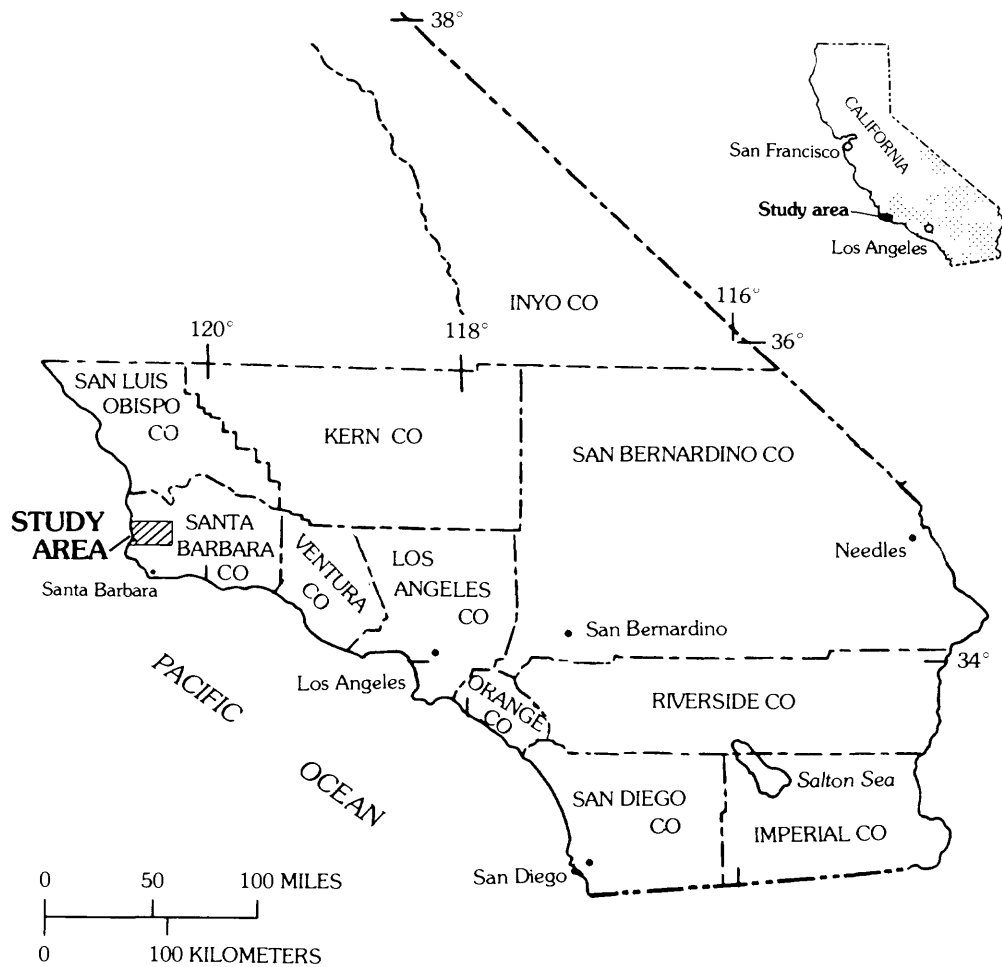
The scope of the study included: (1) describing ground-water levels and

movement in the main water-bearing zone in the study area; (2) collecting and analyzing ground-water samples from wells selected as representative of ground water in the main water-bearing zone; (3) classifying ground water as to predominant ions; (4) detecting areas where specific chemical constituents in the ground water exceed recommended limits for agricultural, municipal, and domestic uses; and (5) comparing ground-water quality in the main water-bearing zone in 1983 to that of 1972.

The cooperation and assistance of the city of Lompoc Water Department in supplying data on chemical quality of water for this study are gratefully acknowledged. The author also expresses his gratitude to the many farmers who made possible the collection of water samples and field data, and to Mr. Bill Gillingham of the Johns-Manville Company who furnished hydrologic data and assisted in sampling wells in San Miguelito Canyon.

SCOPE OF THIS STUDY

- Describing ground-water levels and movement
- Collecting and analyzing ground-water samples
- Classifying ground water
- Detecting areas where constituents exceed recommended limits
- Comparing 1972 and 1983 ground-water quality



Location of study area.

1.0 INTRODUCTION--Continued

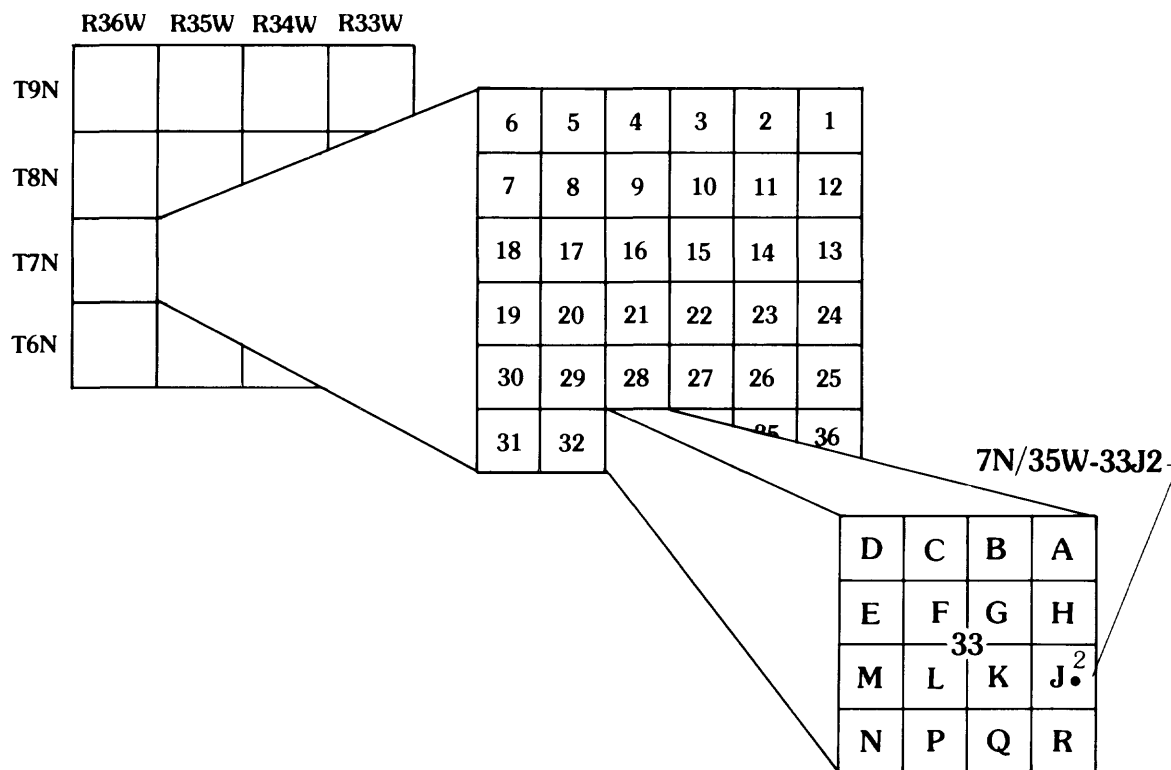
1.2 Well-Numbering System

WELLS ARE NUMBERED ACCORDING TO THEIR LOCATION WITHIN A TOWNSHIP

The well-numbering system used in this report is based on the rectangular subdivision of public lands.

Wells are numbered according to their location in the rectangular system for subdivision of public lands. For example, in well number 7N/35W-33J2, the number and letter preceding the slash indicate the township (T. 7 N.); the number and letter following the slash indicate the range (R. 35 W.); the number following the hyphen indicates the section (sec. 33); the letter (J)

following the section number indicates the 40-acre subdivision. Wells are sequentially numbered in the order they are inventoried (number 2). The area covered by this report lies entirely in the northwest quadrant of the San Bernardino base line and meridian. The diagram on the facing page shows how well number 7N/35W-33J2 is derived.



Well-numbering system used in this report.

2.0 DESCRIPTION OF THE STUDY AREA

2.1 Geographic Setting

THE LOMPOC PLAIN IS IN WESTERN SANTA BARBARA COUNTY, CALIFORNIA

The area of this report is the Lompoc plain. Its climate is Mediterranean, and land use is primarily agriculture. Ground water is the main source of water for all uses.

The Lompoc plain is the broad, flat floor of a coastal valley bounded on the north by the Purisima Hills, on the east by the Santa Rita Hills, on the south by the Lompoc Hills, and on the west by the Pacific Ocean. The land-surface altitude of the plain descends from 120 feet above sea level in the east to about 5 feet in the west near the Pacific Ocean.

Most of the land in the study area is occupied by field crops, flowers, and pastures; a small percentage is occupied by urban development. The main population centers are the city of Lompoc, the U.S. Penitentiary at Lompoc, and Vandenberg Air Force Base.

The Lompoc plain has a Mediterranean climate with warm, dry summers and mild winters. About 95 percent of the precipitation falls between October and April. The mean annual precipitation at

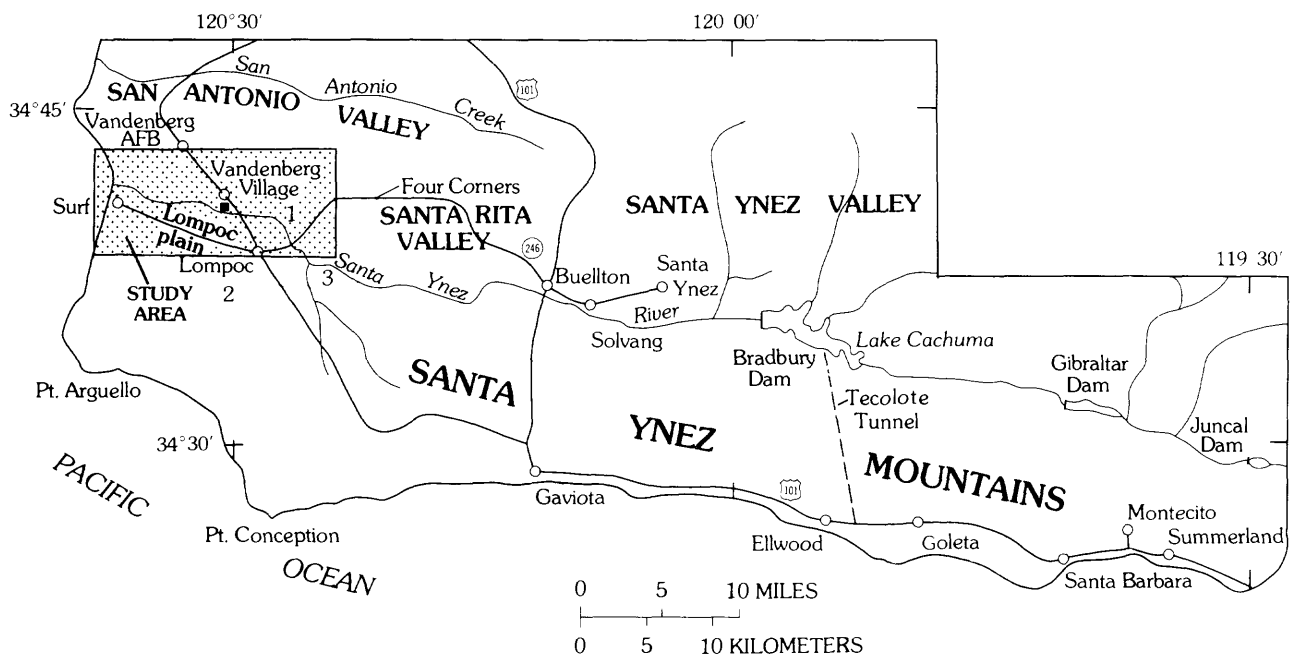
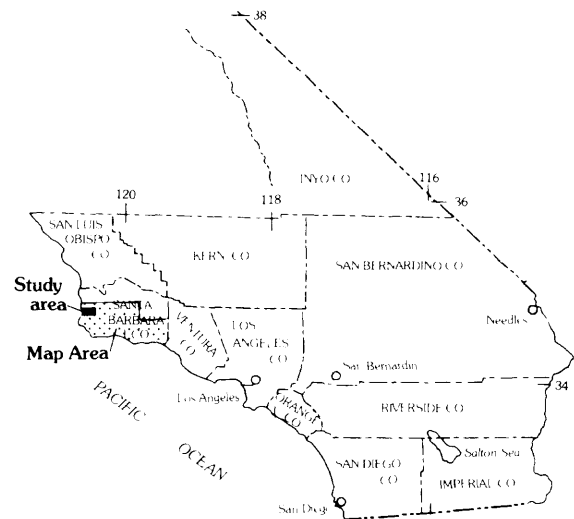
Lompoc is 14.42 inches (National Oceanic and Atmospheric Administration, 1983).

The Santa Ynez River, which originates in the Santa Ynez Mountains, is the principal stream in the area. The river, impounded by several dams, crosses the plain from east to west and empties into the Pacific Ocean north of the town of Surf. Although the Santa Ynez River is a perennial stream, in the Lompoc plain the volume of flow usually is small, and during the summer months flow is maintained by irrigation return and treated sewage effluent.

Ground water is the main source of water in the plain for most purposes. Agriculture probably uses the largest amount of ground water; other users of ground water include the city of Lompoc, Vandenberg Air Force Base, the Johns-Manville Company, and the U.S. Penitentiary at Lompoc.

EXPLANATION

- | | |
|---------------------|--------------------|
| ■ U.S. PENITENTIARY | 2 LOMPOC HILLS |
| 1 PURISIMA HILLS | 3 SANTA RITA HILLS |



Geographic setting of study area.

2.0 DESCRIPTION OF THE STUDY AREA--Continued

2.2 General Geology and Ground-Water Hydrology

THE GROUND-WATER BASIN CONSISTS OF UNCONSOLIDATED DEPOSITS

The main water-bearing zone in the Lompoc plain is the lower member of the younger alluvium. The deposits of this zone yield from 100 to more than 1,000 gallons per minute of water to wells.

The geologic structure underlying the Lompoc plain is a major synclinal trough, the axis of which trends eastward through the Santa Rita Hills toward Buellton. This downwarp, known as the Santa Rita syncline, contains a sequence of marine and continental sediments from Miocene to Holocene in age that total several thousand feet in thickness. The stratigraphic units that compose this sequence and a summary of their water-bearing characteristics are shown on the facing page.

In this report the stratigraphic units are classified as unconsolidated deposits or consolidated rocks on the basis of geohydrologic characteristics.

The unconsolidated deposits consist of sand, silt, clay, and gravel, and comprise river-channel deposits, younger alluvium, terrace deposits, the Orcutt Sand, the Paso Robles Formation, and the Careaga Sand. These deposits range in thickness from zero along the margins of the plain to more than 2,000 feet in the central part.

Consolidated fine-grained rocks comprise the Foxen Mudstone, the Sisquoc Formation, and the Monterey Shale. These rocks underlie the unconsolidated deposits and form the base of the ground-water basin. The consolidated rocks also bound much of the perimeter of the ground-water basin, where they have been uplifted and exposed in the mountains and hills. Except where fractured and weathered, the consoli-

dated rocks are nearly impermeable and are not an important source of ground water.

The younger alluvium is the major aquifer in the Lompoc plain. The alluvium is as much as 180 feet thick and is divided in most of the plain into an upper member and a lower member. The upper member has been termed the shallow zone and the lower member the main water-bearing zone by Miller (1976).

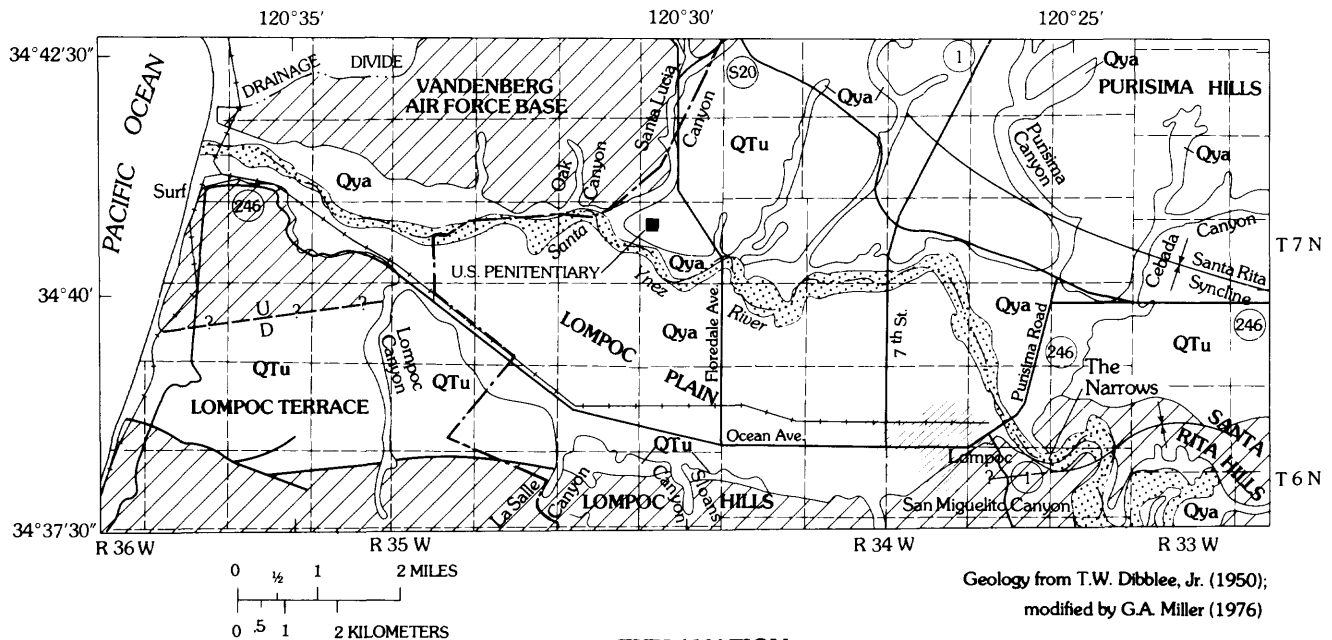
The shallow zone consists predominantly of fine sand, silt, and clay. The fine-grained deposits of the shallow zone confine or partly confine the underlying main water-bearing zone throughout most of the Lompoc plain. The shallow zone does not yield water freely to wells and is used mainly for domestic supplies. Average dissolved-solids concentration in samples from wells perforated in the shallow zone is about 2,000 mg/L (milligrams per liter) (Miller, 1976, p. 55).

The main water-bearing zone, the lower member of the younger alluvium, consists of sand and gravel that yield from 100 to more than 1,000 gallons per minute of water to wells in the Lompoc plain. Most of the large production wells in the plain are perforated in this zone. The dissolved-solids concentrations in samples from wells perforated in the main water-bearing zone are less than 1,500 mg/L throughout most of the Lompoc plain (Miller, 1976, p.45).

Stratigraphic units of the Lompoc plain and vicinity

[Modified from Miller (1976, p. 12). gal/min, gallons per minute; mg/L, milligrams per liter]

System	Series	Formation	Thickness (feet)	Lithologic character	Water-bearing properties
Quaternary	Holocene	River-channel deposits	30-40	Coarse to fine sand with some gravel in channel of Santa Ynez River.	Unconsolidated; permeable, not tapped by wells in area; upstream, yields 500-1,000 gal/min to wells.
		Unconformity			
		Younger alluvium	0-180	Gravel, sand, silt, and some clay underlying plain and tributary streams; channel deposits of tributaries. Two members: upper fine sand and silt; lower coarse sand and gravel.	Unconsolidated; upper member slightly to moderately permeable with high dissolved-solids concentrations (2,000 mg/L). Permeable lower member makes up most of main water-bearing zone. Yields 1,000 gal/min to many wells.
	Pleistocene	Unconformity			
		Terrace deposits	0-150	Crossbedded sand, gravel, and clay.	Unconsolidated; somewhat permeable, rapid drainage, largely unsaturated.
		Unconformity			
Quaternary(?) and Tertiary	Pleistocene(?) and Pliocene	Orcutt Sand	0-300	Sand and clay, interbedded gravel. Locally, cap rock of indurated sandstone.	Unconsolidated; locally yields small quantities to wells where saturated.
		Unconformity			
	Pliocene	Paso Robles Formation	0-2800±	Poorly sorted gravel, sand, silt, and clay.	Unconsolidated; yields less than 100 to more than 1,000 gal/min.
		Careaga Sand	450-1,000±	Sand, some silt and gravel. Two members locally: upper coarse-grained sandstone and sand; lower fine-grained sandstone and sand.	Unconsolidated; upper member yields large quantities of water to properly constructed wells; tapped by few wells. Lower member only slightly permeable; not tapped by wells.
Tertiary	Local unconformity				
	Pliocene to Miocene	Foxen Mudstone Sisquoc Formation Monterey Shale.	2,000±	Mudstone, siltstone, shale, and sandstone.	Consolidated or highly compacted; minor supplies in joints or fractures. Not tapped by wells.



EXPLANATION

- RIVER-CHANNEL DEPOSITS OF HOLOCENE AGE
- YOUNGER ALLUVIUM OF HOLOCENE AGE
- TERRACE DEPOSITS, ORCUTT SAND, PASO ROBLES FORMATION, AND CAREAGA SAND OF PLEISTOCENE AND PLIOCENE AGE
- CONSOLIDATED ROCKS OF TERTIARY AGE
- FAULT—Dashed where approximately located, queried where doubtful; D, downthrown side; U, upthrown side
- ANTICLINE—Showing trace of axial plane; dashed where approximately located, queried where doubtful
- SYNCLINE—Showing trace of axial plane
- Boundary of Vandenberg Air Force Base

Generalized geology of study area.

3.0 APPROACH AND METHODS

3.1 Collection of Ground-Water Data

WATER LEVELS WERE MEASURED AND SAMPLES WERE COLLECTED

Water levels were measured and samples were collected in wells perforated only in the main water-bearing zone. Water levels were measured in 76 wells, and water-quality samples were collected from 53 wells.

Ground-water levels were measured during this study in 75 wells perforated only in the main water-bearing zone. The depth to water in wells was measured with a steel tape.

Ground-water samples for chemical analyses were collected during the study from 53 wells that are perforated in the main water-bearing zone. All ground-water samples were collected and analyzed by the U.S. Geological Survey, except for samples from six wells (7N/34W-27N5, -27P5, -27Q2 and 7N/35W-34A4, -34B1, -34F6) owned by the city of Lompoc. The samples from these six wells were collected and analyzed by the city of Lompoc. The types of wells sampled include irrigation (26 wells), industrial (1 well), municipal (10 wells), domestic (4 wells), and observation (12 wells). An attempt was made to sample all wells that had been sampled during 1972 by Miller (1976); however, many of the wells could not be resampled in 1983 because they had either been destroyed or were not in service. Only seven wells sampled in 1972 were resampled for this study.

Distributions of concentrations of individual chemical constituents are discussed and shown on maps. Throughout the study area, mapping of distributions was controlled by the availability of wells meeting the criteria for sampling.

Water-quality data were not collected from the southwestern part of the plain because wells there were not pumped at the time of sampling.

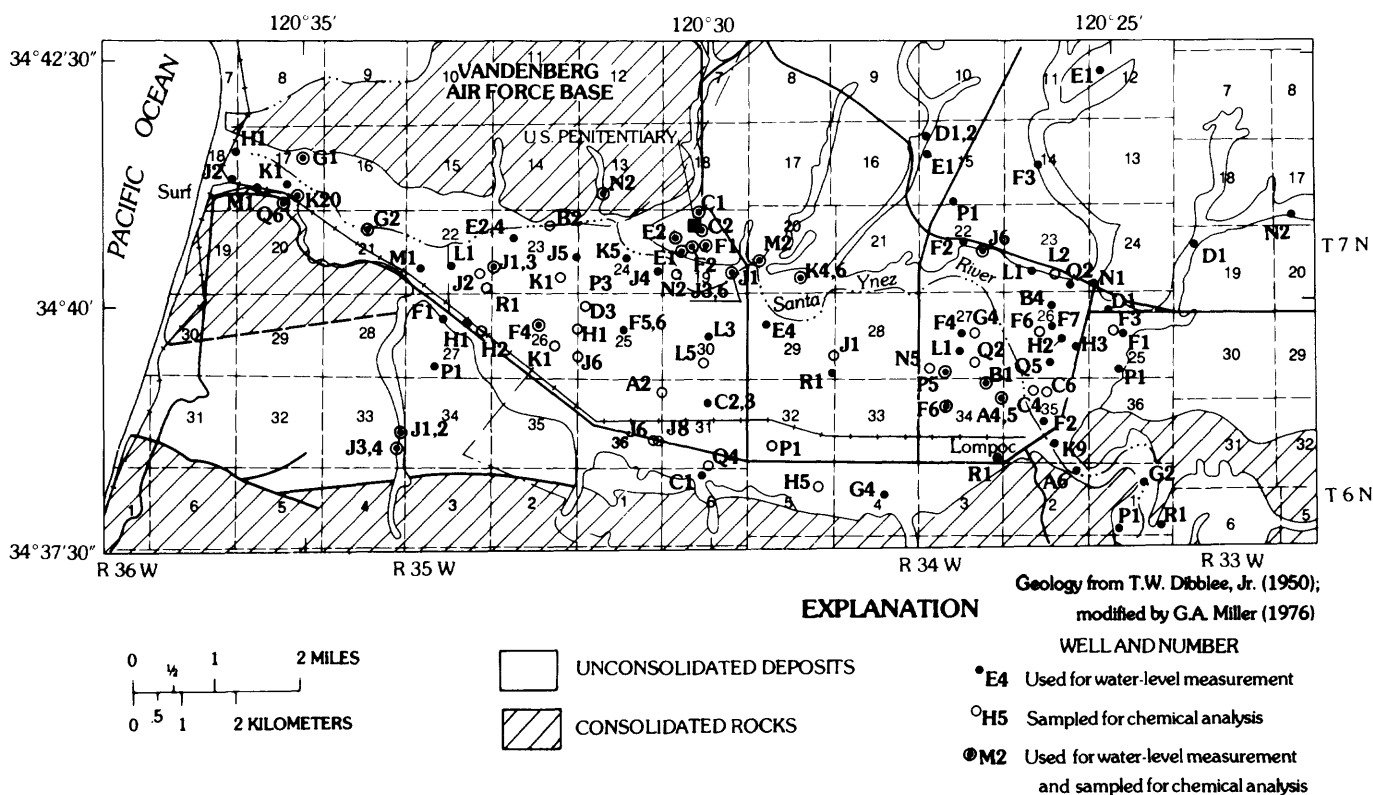
Where possible, ground-water-quality samples were collected from pumped wells. Wells were pumped long enough (usually sufficient time to discharge $1\frac{1}{2}$ times the casing volume) to allow the water standing in the casing to be displaced with water from the aquifer before the sample was collected. In addition, specific conductance of the discharge water was monitored, and sampling was delayed until after specific conductance had stabilized. If untreated water could not be obtained from a well before pressure tanks or treatment apparatus had been used, that well was not sampled.

Field determinations of specific conductance, water temperature, pH, and alkalinity were made according to standard U.S. Geological Survey procedures. Temperature of samples was taken with a hand-held mercury-filled thermometer that has a full-scale accuracy of 0.5 °C and that has been calibrated with an American Society for Testing and Materials¹ standard laboratory thermometer. Specific conductance and pH were measured with portable meters. Alkalinity was determined by the electrometric titration process,

¹Use of the firm name in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

usually to a pH of 4.5, as described by Brown and others (1970, p. 42). In an attempt to reduce errors, duplicate field measurements were made. Samples for dissolved constituents were filtered in the field through 0.45- μ m-pore-size cellulose acetate membrane filters. Samples for cations were acidified with nitric acid to a pH of less than 2. Samples for nutrients were preserved with one HgCl₂/NaCl₂ tablet (13 mg [milligrams] of mercuric chloride and 172 mg of sodium chloride).

Samples were chilled and sent within 24 hours to the U.S. Geological Survey Water-Quality Laboratory in Denver, Colorado, and analyzed for concentration of alkalinity, boron, calcium, chloride, fluoride, hardness, iron, magnesium, nutrients (Kjeldahl nitrogen, ammonia, nitrate plus nitrite, organic nitrogen, and orthophosphate), potassium, dissolved solids, silica, sodium, and sulfate. Methods for analysis of most constituents are as specified by Skougstad and others (1979).



Location of wells sampled.

3.0 APPROACH AND METHODS--Continued

3.2 Analysis of Ground-Water-Quality Data

CONCENTRATIONS OF CONSTITUENTS ARE COMPARED TO RECOMMENDED LIMITS

Concentrations of constituents are compared to recommended limits set by governmental regulations for public drinking-water supplies and to recommended limits for irrigation water.

The quality of water can affect humans, livestock, and irrigated agriculture. Chemical constituents considered in this report are limited to those which are indicative of degraded water quality and for which government agencies have established standards and recommended limits. These constituents are discussed in terms of human toxicity or annoyance and agricultural toxicity. Industrial standards are not discussed because they vary with the needs of individual industries.

For drinking-water supplies a distinction is made between primary and secondary regulations. Primary regulations pertain to constituents that may present a health hazard; secondary regulations to constituents that may be detrimental to esthetic qualities but do

not present a health hazard. The California Department of Health primary and secondary drinking-water limits (California Department of Health, 1977) are identical to the U.S. Environmental Protection Agency limits (U.S. Environmental Protection Agency, 1977 and 1979).

The National Academy of Sciences and National Academy of Engineering (1973) provide recommendations for concentrations of certain elements in water for irrigation. McKee and Wolf (1963), Ayers (1977), and others also have set forth recommended limits for irrigation water. Recommendations vary with type of soil and with farming practices. There are no governmental regulations for irrigation water.

**Recommended limits for selected chemical constituents
in drinking and irrigation water**

[For irrigation water, the lower value is the recommended maximum concentration for use continuously on all soils; the higher value is the recommended maximum concentration for use of fine-textured, neutral to alkaline soils for up to 20 years (National Academy of Sciences and National Academy of Engineering, 1973)]

Constituent	Concentrations, in milligrams per liter		
	Environmental Protection Agency drinking-water regulations (1977 and 1979)		Irrigation water
	Primary	Secondary	
Chloride-----	--	250	¹ 700
Fluoride-----	22.0	--	1.0-15.0
Iron-----	--	0.3	5.0-20.0
Nitrate-nitrogen-----	10	--	--
Sulfate-----	--	250	(³)
Dissolved solids-----	--	500	(⁴)

¹Chloride concentrations as high as 700 mg/L can be used on most crops without incurring toxic effects (National Academy of Sciences and National Academy of Engineering, 1973).

²Limit (1.4-2.6 mg/L) is adjusted according to maximum daily air temperature in the study area.

³Refer to section 5.5.

⁴Refer to section 5.1.

4.0 GROUND-WATER CONDITIONS

4.1 *Ground-Water Movement and Levels*

GROUND-WATER MOVEMENT AND LEVELS ARE DESCRIBED

Ground-water movement in the Lompoc plain is westward toward the Pacific Ocean.

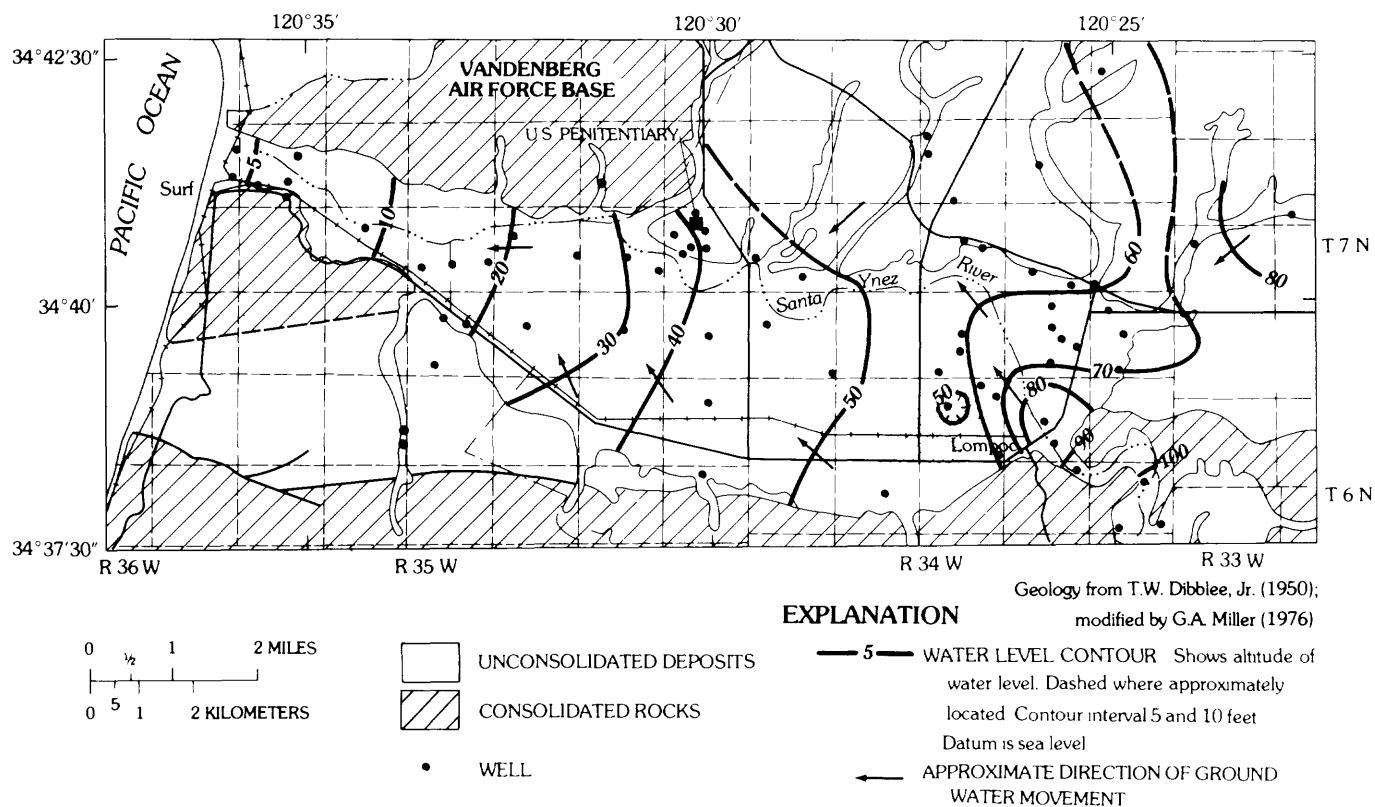
Ground-water levels in the main water-bearing zone throughout most of the plain have not changed significantly since the 1940's.

Ground-water movement in the Lompoc plain is perpendicular to water-level contours and generally follows the surface-drainage patterns. Ground water in the main water-bearing zone moves westward and discharges to the ocean. Some of the water pumped from this zone for irrigation and municipal use is returned to the shallow zone. Ground water in the shallow zone also moves westward and discharges into the Santa Ynez River or into a marshland extending several miles eastward from the mouth of the river. Upson and Thomasson (1951) and Miller (1976) described similar ground-water movement for the early 1940's and 1972.

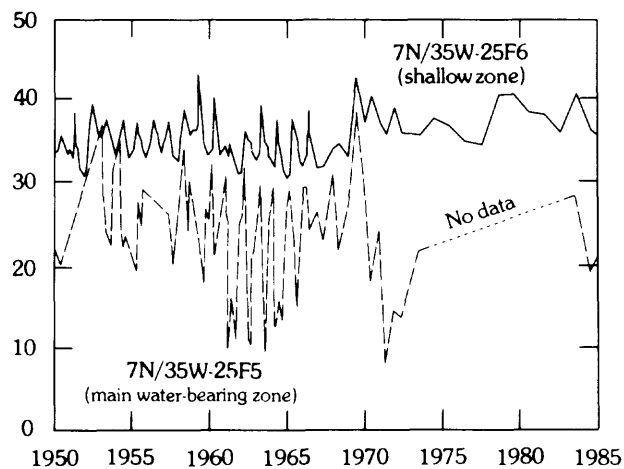
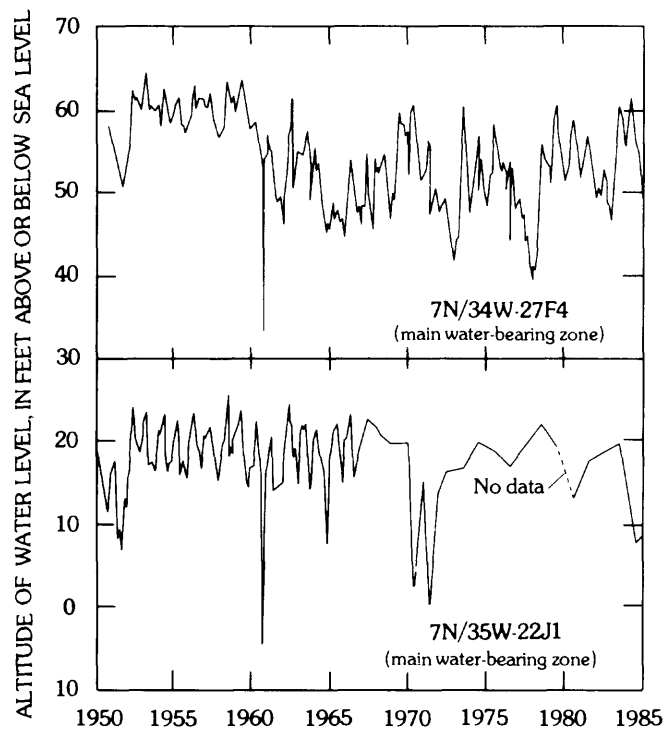
Ground water also moves vertically between the two water-bearing zones. Because the shallow zone has a higher hydraulic head than the main water-bearing zone throughout most of the

plain, ground water moves from the shallow zone to the main water-bearing zone. (See hydrographs for selected shallow-zone and main-water-bearing-zone wells on opposite page.)

Even though extensive agricultural development has taken place in the Lompoc plain, discharge apparently has been balanced by recharge. Natural recharge to the ground-water basin is derived from infiltration of streamflow and precipitation, and from ground-water underflow. Irrigation return flows and treated sewage effluent also are considered recharge. Long-term hydrographs for selected wells in the plain indicate little change in ground-water levels during 1950-85. Short-term fluctuations in the hydrographs reflect water-level response to seasonal pumpage and recharge.



Generalized ground-water movement and altitude of water level, spring 1983.



Long-term water levels for selected wells in study area.

4.0 GROUND-WATER CONDITIONS--Continued

4.2 Seasonal Ground-Water-Level Changes

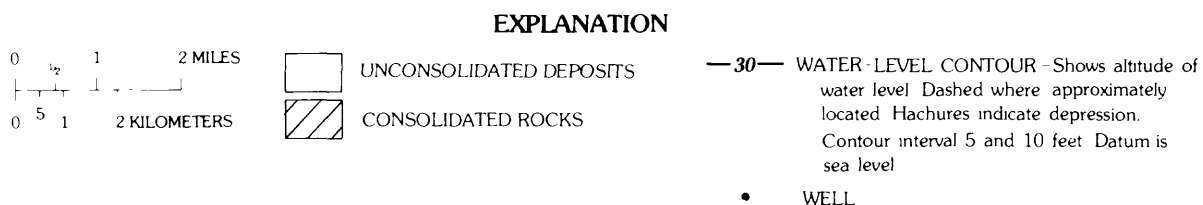
GROUND-WATER LEVELS IN THE MAIN WATER-BEARING ZONE RESPOND TO SEASONAL PUMPING AND RECHARGE

Ground-water levels in the main water-bearing zone declined about 15 feet in the central part of the plain between spring and autumn 1982 in response to pumping, and then recovered by spring 1983 in response to recharge from streamflow and precipitation.

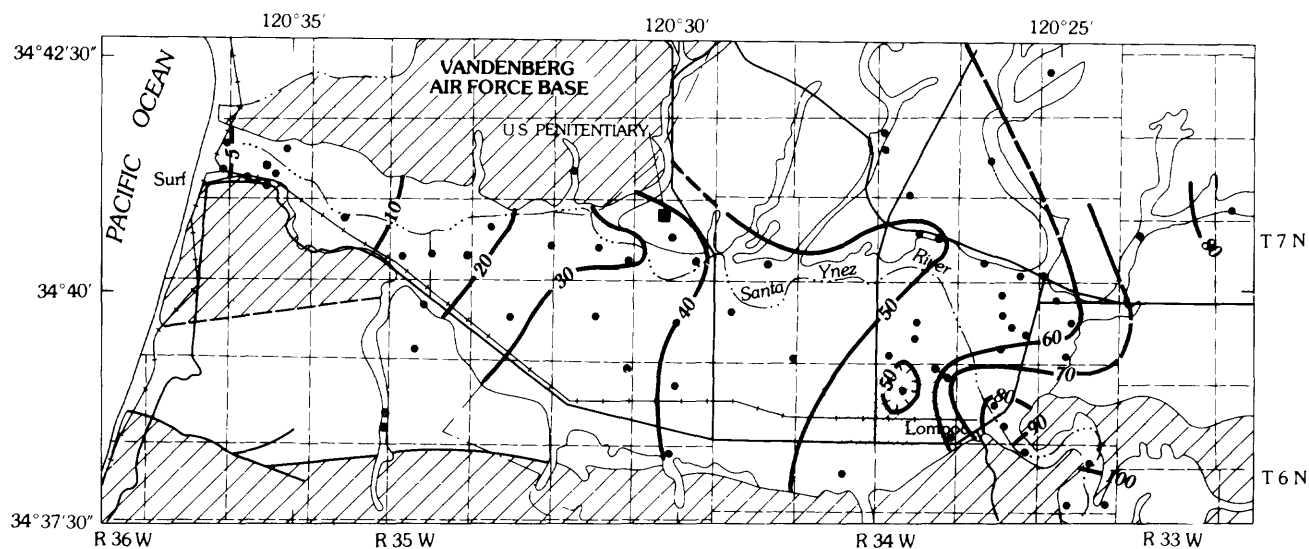
Seasonally, ground-water levels in the main water-bearing zone usually start to decline in late March or April with the onset of pumping for irrigation. Water levels continue to decline throughout the summer and autumn in response to increased pumping for irrigation, municipal, and military uses. Aquifer recharge from streamflow and precipitation occurs primarily from October to April.

Maps on the facing page show altitude of water level in the main water-bearing zone for spring 1982, autumn 1982, and spring 1983. The aquifer in spring 1982

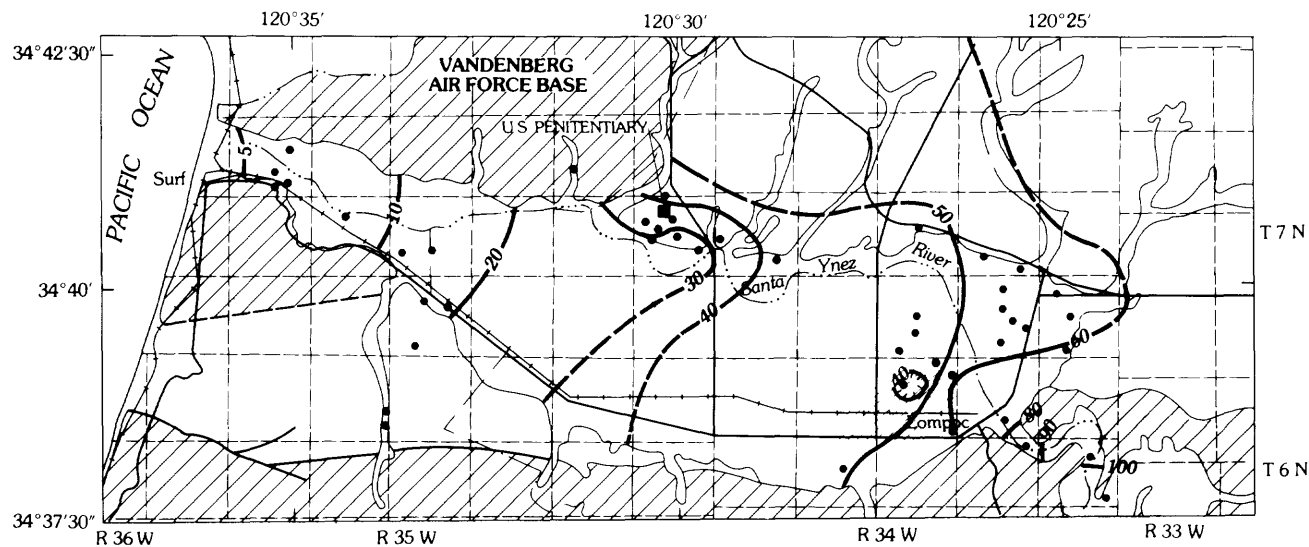
was considered to be nearly full; by autumn a broad, flat cone of depression had developed in the central part of the plain. Maximum water-level declines were about 15 feet and probably can be attributed to agricultural pumping and to pumping from the Vandenberg Air Force Base well field. Water-level declines of more than 10 feet near the city of Lompoc probably can be attributed to municipal and agricultural pumping in the area. The spring 1983 map shows that the main water-bearing zone in most areas completely recovered from summer 1982 pumping as a result of recharge from streamflow and precipitation.



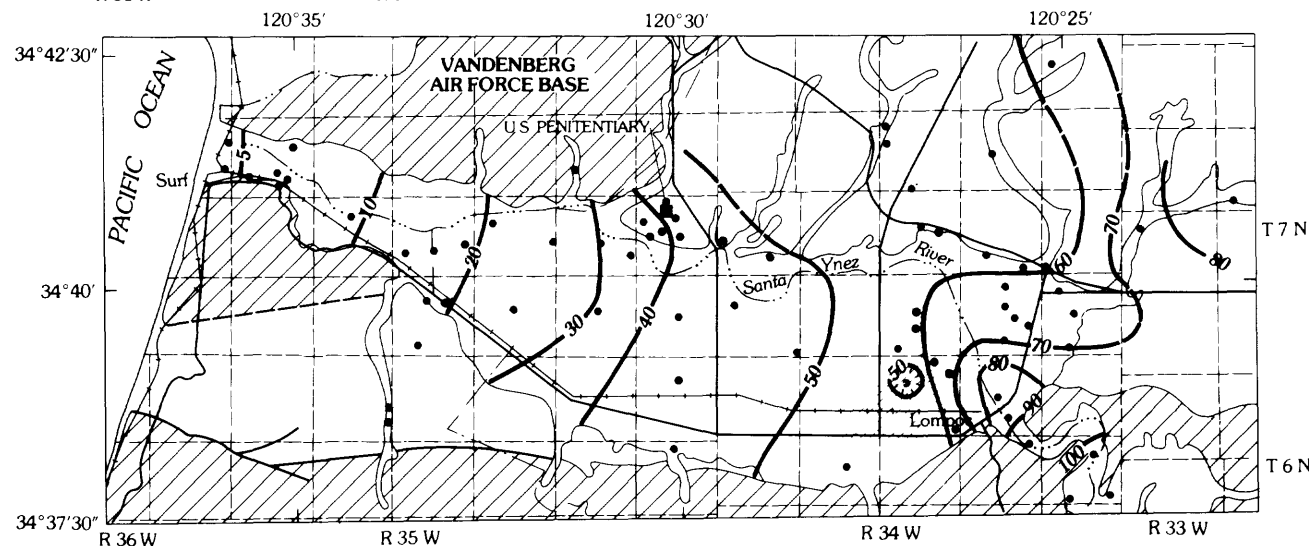
SPRING 1982



AUTUMN 1982



SPRING 1983



Geology from T.W. Dibblee, Jr. (1950);
modified by G.A. Miller (1976)

Altitude of water level in the main water-bearing zone.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE

5.1 Dissolved Solids

DISSOLVED-SOLIDS CONCENTRATIONS EXCEEDED RECOMMENDED LEVELS THROUGHOUT THE STUDY AREA

Dissolved-solids concentrations in all samples exceeded the secondary maximum contaminant level for drinking water; concentrations in 69 percent failed to meet the "good" classification (500-1,000 milligrams per liter) for irrigation.

Dissolved-solids concentration is an indicator of general water quality and provides a simple means to evaluate and compare waters. A high dissolved-solids concentration is generally considered to be the characteristic most indicative of ground-water degradation or pollution.

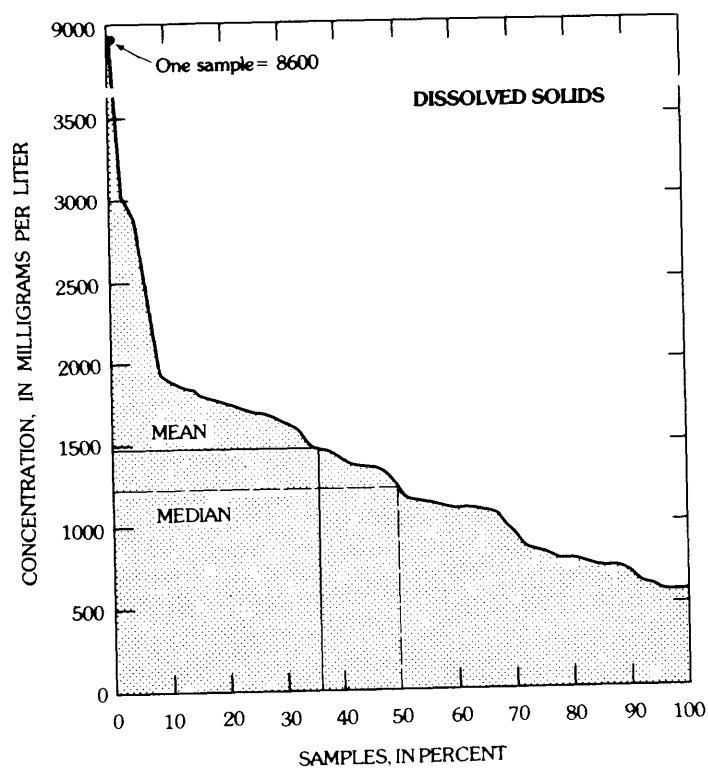
High dissolved-solids concentrations in water may be objectionable to users because of odor, taste, and staining. Excessive concentrations of specific constituents can be physiologically harmful to humans. The U.S. Environmental Protection Agency (1979), in its secondary drinking-water regulations, recommended a maximum contaminant level of 500 mg/L (milligrams per liter) for dissolved solids if other sources are available. Water exceeding this level can be used for drinking without ill effects; however, the usability of water should be evaluated according to the concentration of each chemical constituent.

No detrimental effects are observed on crops irrigated with water containing less than 500 mg/L of dissolved solids. Chapman and others (1949, p. 136) suggested that 1,000 mg/L is near the maximum limit for unimpaired crop growth in California. Suggested guideline concentrations for dissolved solids in irrigation water (modified from National

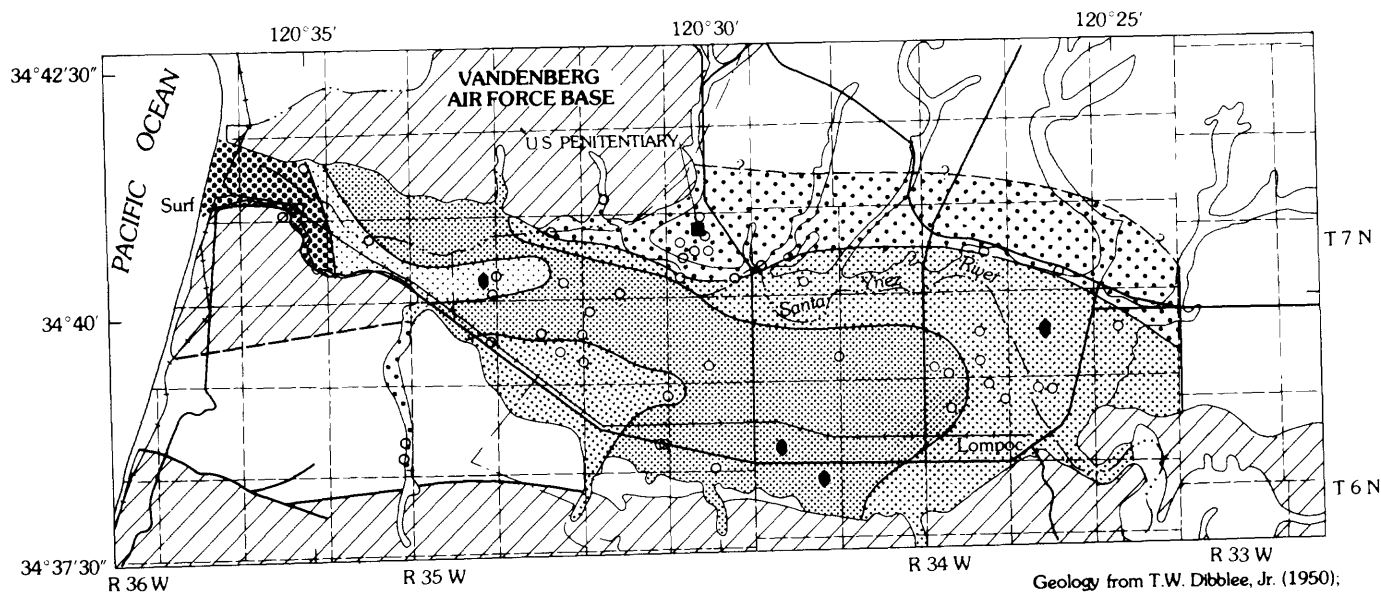
Academy of Sciences and National Academy of Engineering, 1973), and their distribution in wells in the study area, are:

Crop-response designation (classification)	Dissolved-solids concentration (milligrams per liter)	Distribution in study area (percentage of wells)
Excellent--No detrimental effects noticed-----	500	0
Good--Can affect sensitive crops-----	500-1,000	31
Permissible--Can affect most crops-----	1,000-2,000	61
Doubtful--Can be applied to tolerant crops on permeable soils-----	2,000-5,000	6
Unsuitable--Can have detrimental effects----	>5,000	2

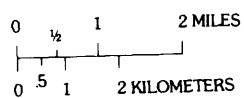
Concentrations of dissolved solids in the samples (facing page) ranged from 590 to 8,600 mg/L; the mean value was 1,484 and the median, 1,236 mg/L. Concentrations exceeded 1,000 mg/L in 69 percent of the wells sampled. Concentrations were generally lower in the northeast part of the study area, near the Purisima Hills, and higher in the western part. Water sampled from well 7N/35W-17Q6 in the western part of the study area, near the coast, contained the highest concentration of 8,600 mg/L.



Percentage of samples in which indicated concentrations were equaled or exceeded.

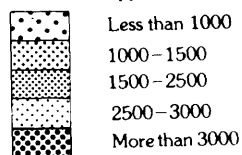


EXPLANATION



- UNCONSOLIDATED DEPOSITS
- CONSOLIDATED ROCKS
- WELLS
 - Dissolved-solids concentration measured
 - Dissolved-solids concentration computed from measurement of specific conductance

DISSOLVED-SOLIDS CONCENTRATION, IN MILLIGRAMS PER LITER - Lines dashed where approximately located, queried where doubtful



Areal distribution of dissolved solids, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.2 Predominant Ions

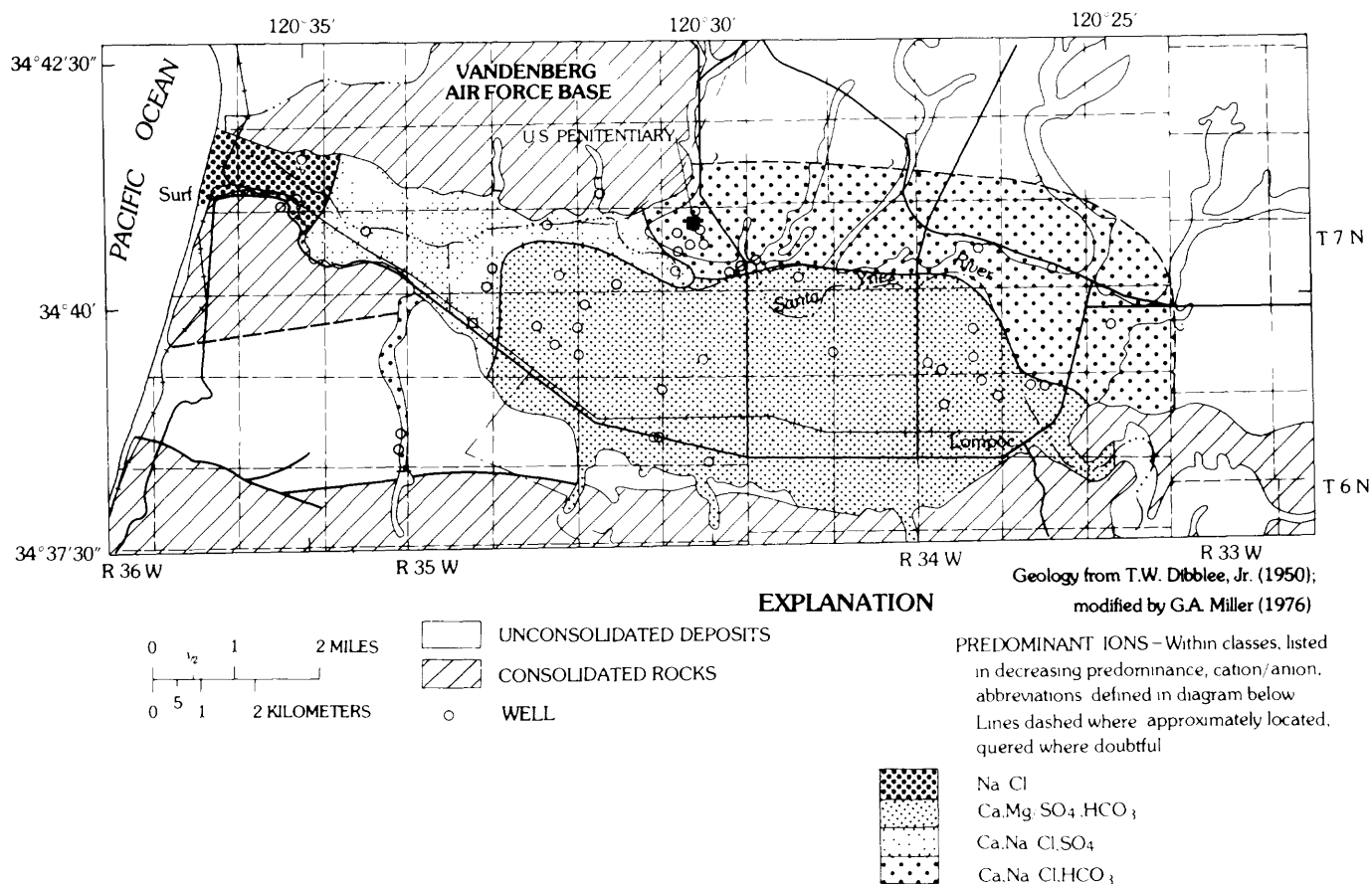
PREDOMINANT IONS WERE CALCIUM, MAGNESIUM, SULFATE, AND BICARBONATE

The predominant ions in 41 percent of the samples were calcium, magnesium, sulfate, and bicarbonate.

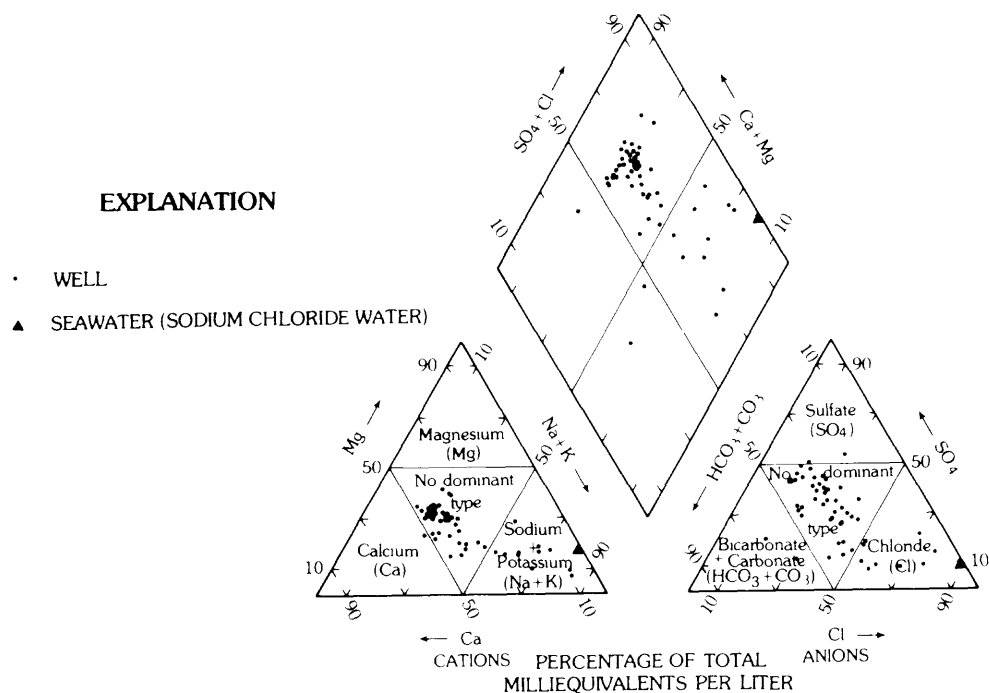
The chemical composition of water samples in the Lompoc plain, in 1983, is depicted in the Piper diagram (opposite page). Scales along the sides of the diagram indicate the percentages (based on milliequivalents per liter) of each major ion. Cations are shown in the left triangle and anions in the right triangle. The central diamond integrates the data for cations and anions but is not essential to interpreting the data. For example, in a sample in which magnesium accounts for 50 percent or more of the cations, and bicarbonate for 50 percent or more of the anions, magnesium and bicarbonate are the predominant ions. If no one cation or anion accounts for at least 50 percent of the total, the predominant ions are those with the largest percentages (Piper and others, 1953, p. 26). Each water sample is represented by a dot on the diagram. Four samples were omitted because of incomplete data for one or more ions.

Eighty percent of the samples had no single predominant cation; sodium (plus potassium) was the predominant cation in 18 percent. Eighty percent of the samples also had no single predominant anion; chloride was the predominant anion in 14 percent. In 41 percent of the samples calcium, magnesium, sulfate, and bicarbonate were the predominant ions; in 14 percent, calcium, sodium, chloride, and bicarbonate were predominant; and in 8 percent, sodium and chloride were predominant.

In the northeast part of the plain and in Lompoc Canyon in the western part, calcium, sodium, chloride, and bicarbonate were the predominant ions. In a large area that includes the city of Lompoc and extends westward about 5 miles, the predominant ions were calcium, magnesium, sulfate, and bicarbonate. Farther west, calcium, sodium, chloride, and sulfate were the predominant ions. In a small area in the far western part of the plain, near the coast, sodium and chloride were the predominant ions.



Areal distribution of predominant ions, 1983.



Chemical composition of water in the main water-bearing zone.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.3 Hardness

HARDNESS VALUES WERE HIGH

Hardness is caused by calcium and magnesium dissolved in the water. Hardness values generally exceeded 180 milligrams per liter; such water is designated "very hard."

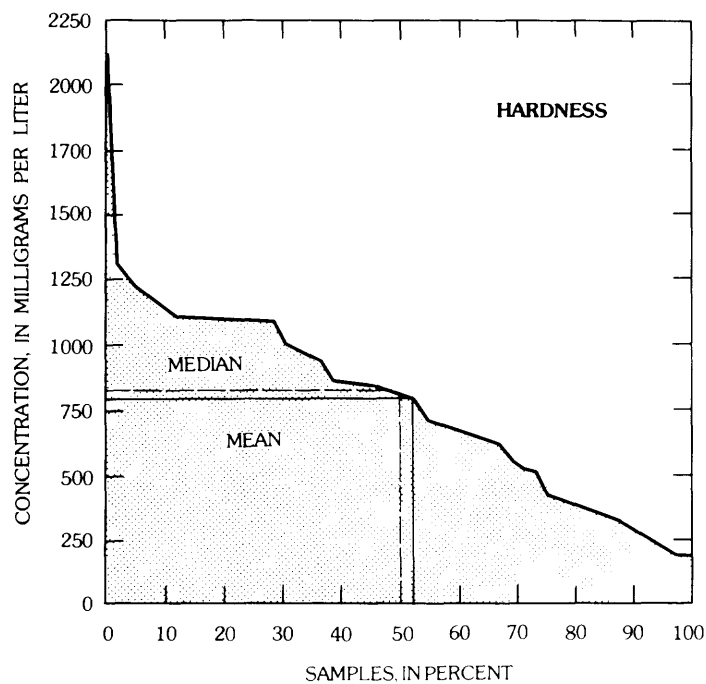
Hardness (also called total hardness or hardness as CaCO_3) is defined as the sum of the concentrations of calcium and magnesium ions expressed in milligrams per liter as CaCO_3 . Hardness is calculated by adding the milliequivalents of calcium and magnesium, and then multiplying the sum by 50.

Water is classified, on the basis of human experiences, as hard or soft. From a practical standpoint, a hardness value is a reflection of the amount of soap needed in washing.

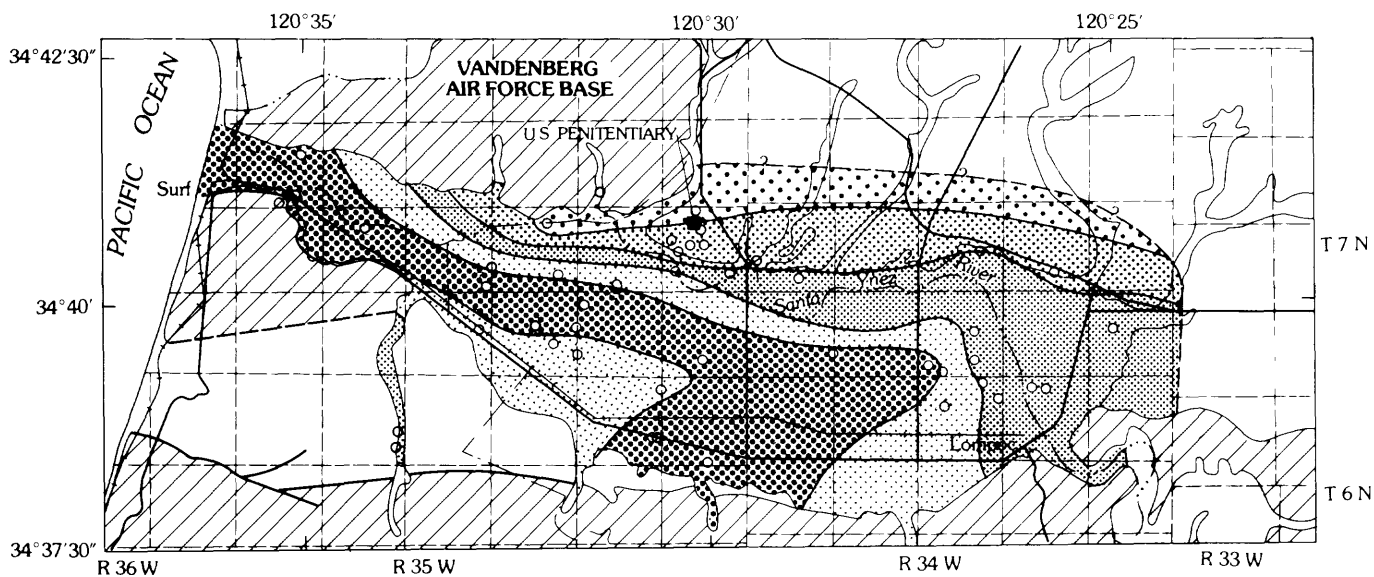
There are no water-quality standards for hardness in water; however, hardness in excess of 180 mg/L (milligrams per liter) (as CaCO_3) may be objectionable because of soap consumption and encrustation in water heaters and low-pressure boilers (Hem, 1985). A hardness classification developed by Hem is shown in the table that follows.

Designation (classification)	Hardness range (mg/L of CaCO_3)
Soft-----	less than 60
Moderately hard-----	60-120
Hard-----	121-180
Very hard-----	greater than 180

Hardness values throughout the study area equaled or exceeded 180 mg/L, ranging from 180 to 2,200 mg/L. The mean was 792 and the median, 820 mg/L. Hardness values exceeded 1,000 mg/L in 31 percent of the wells sampled. The lower concentrations generally were in the northeastern part of the plain. The higher values generally were in the central and western parts; the highest value, 2,200 mg/L, was from well 7N/35W-17Q6.



Percentage of samples in which indicated concentrations were equaled or exceeded.



Geology from T.W. Dibblee, Jr. (1950);
modified by G.A. Miller (1976)

EXPLANATION

0 1/2 1 2 MILES
0 .5 1 2 KILOMETERS

UNCONSOLIDATED DEPOSITS
CONSOLIDATED ROCKS
WELL

HARDNESS CONCENTRATION AS CaCO_3 , IN
MILLIGRAMS PER LITER - Lines dashed where
approximately located, quened where doubtful

Less than 250
250 - 500
500 - 750
750 - 1000
More than 1000

Areal distribution of hardness, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.4 Sodium and Potassium

SODIUM CONCENTRATIONS GENERALLY WERE HIGH AND POTASSIUM CONCENTRATIONS WERE LOW

No Federal standards for sodium or potassium in drinking water have been established. Sodium concentrations exceeded the recommended level for persons on a restricted-sodium diet. Potassium concentrations in all samples were low.

Sodium in drinking water can adversely affect individuals who must restrict sodium in their diets. Because the quantity of sodium that causes these effects varies greatly, no Federal standards for sodium in drinking water have been established. However, on the basis of assumptions regarding water intake, it has been suggested that sodium concentrations in excess of 20 mg/L (milligrams per liter) could be harmful to a person on a sodium-restricted diet (allowing 500 mg/d [milligrams per day]); for moderately restricted diets (allowing 1,000 mg/d), concentrations in excess of 270 mg/L should be avoided (U.S. Environmental Protection Agency, 1977).

Although sodium is needed in limited quantities for most plant growth, high concentrations are toxic to plants. Also, high concentrations of sodium reduce permeability of soil by closing its pores; this makes it difficult to supply crops with water. Bouwer (1978, p. 363) suggested that sodium concentrations greater than 69 mg/L in water used for sprinkler irrigation may cause defoliation or leaf burn in some plants.

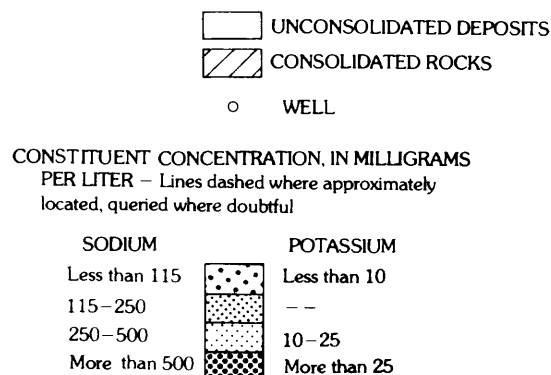
Sodium concentrations in the study area ranged from 75 to 2,400 mg/L; the mean value was 208 and the median, 140 mg/L. Sodium concentrations exceeded the suggested limits for sodium-restricted and moderately restricted diets of 20 mg/L and 270 mg/L in 100 percent and 6 percent, respectively, of the wells sampled. Concentrations in all wells exceeded the recommended limit, 69 mg/L, for sprinkler irrigation. Concentrations generally were lower in the eastern part of the plain and higher near the coast.

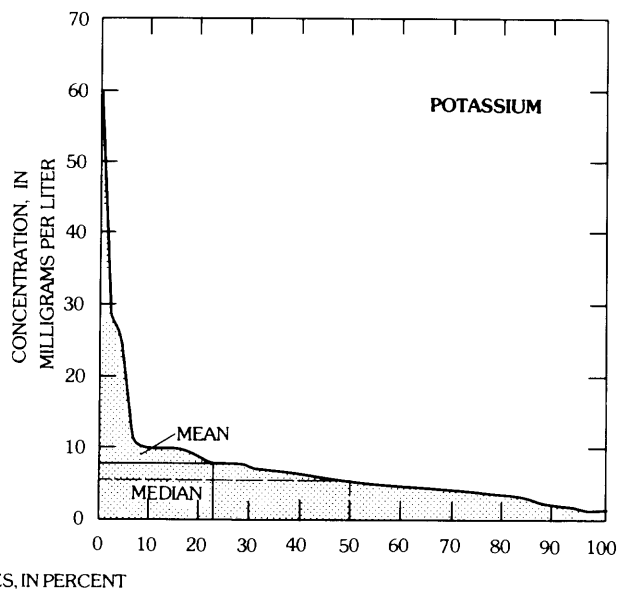
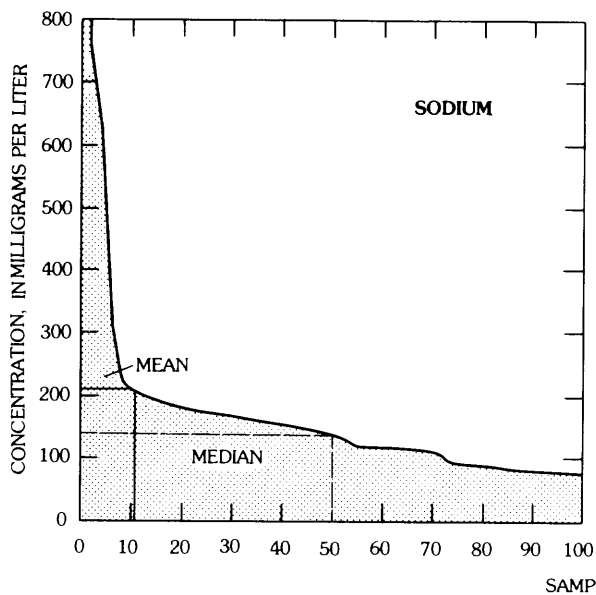
High potassium concentrations in drinking water may have a cathartic effect on persons accustomed to water with low potassium concentrations. Acclimatization to high-potassium water is such that it is not usually considered a health hazard. No Federal drinking-water standards for potassium have been established. However, a concentration of 1,000-2,000 mg/L of potassium is regarded as the extreme limit for drinking water (McKee and Wolf, 1963).

In irrigation waters potassium and sodium have similar effects on plants, but potassium is considered less harmful than sodium. Potassium in low concentrations is essential for plant growth.

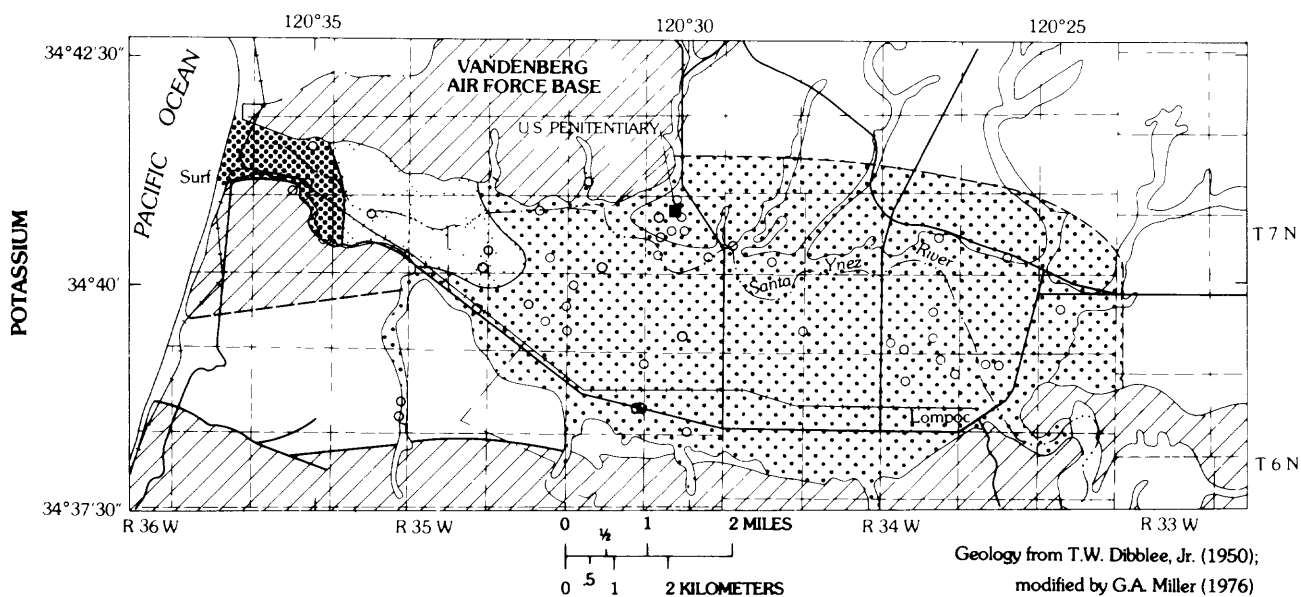
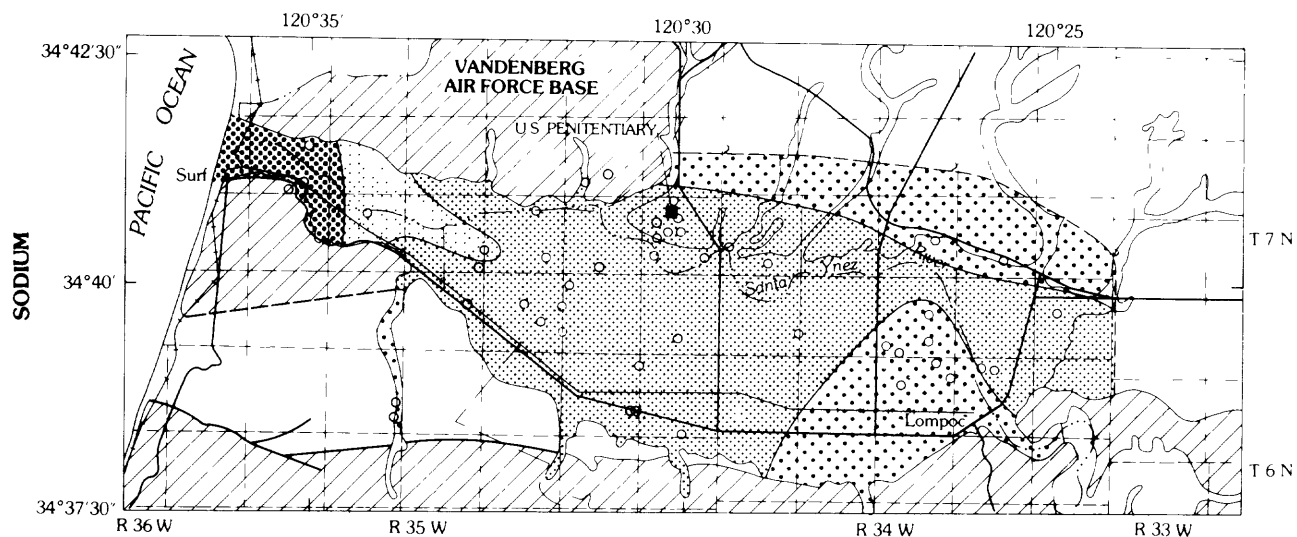
Potassium concentrations generally were less than 10 mg/L; the mean value was 7.7 and the median, 5.4 mg/L. Concentrations greater than 10 mg/L occurred in 12 percent of the wells sampled--all in the western part of the plain. Well 7N/35W-17Q6 had the highest concentration of 68 mg/L.

EXPLANATION





Percentage of samples in which indicated concentrations were equaled or exceeded.



Areal distribution of sodium and potassium, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.5 Sulfate

SULFATE CONCENTRATIONS EXCEEDED RECOMMENDED LEVELS THROUGHOUT MOST OF THE PLAIN

Sulfate concentrations in 67 percent of the samples exceeded the secondary maximum contaminant level for drinking water, and in 56 percent failed to meet the "good" classification for irrigation water.

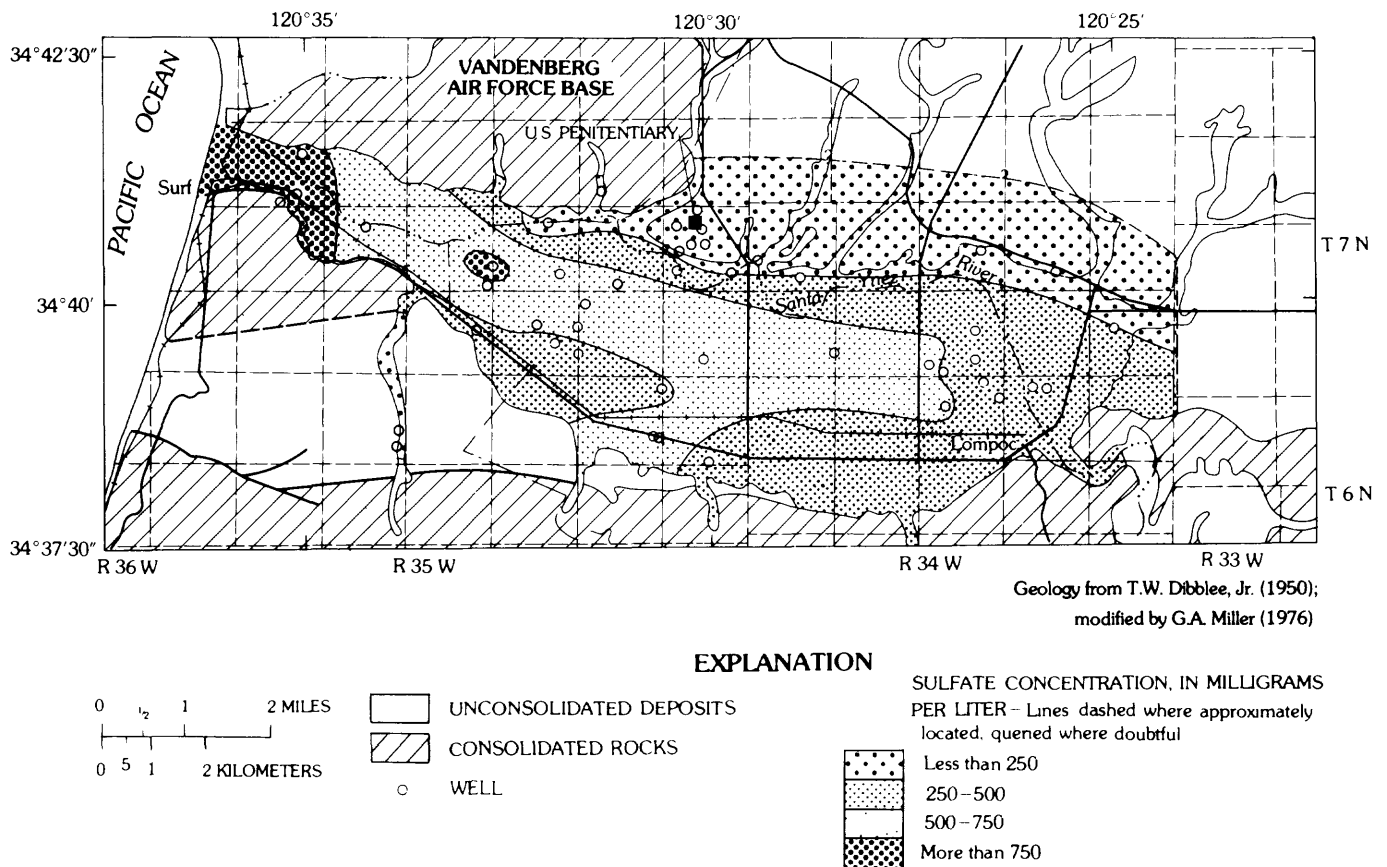
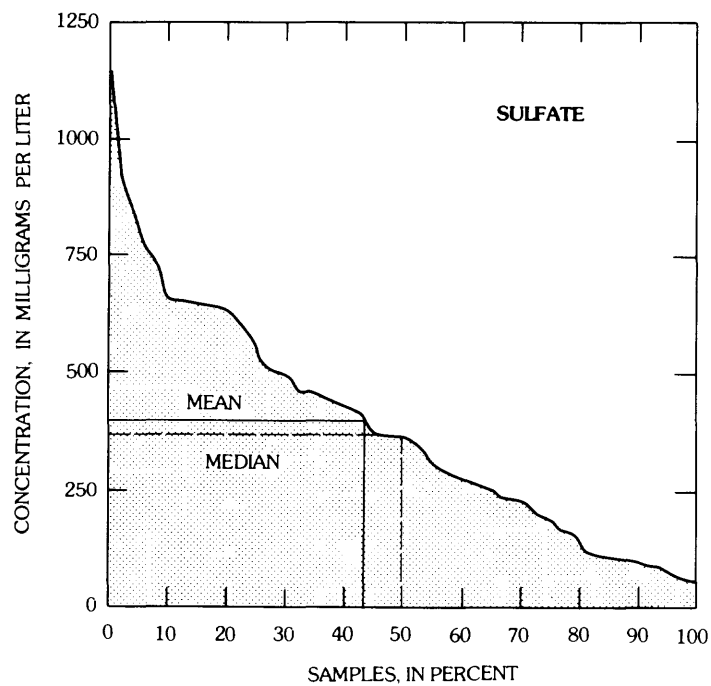
High sulfate concentrations in drinking water may have a cathartic effect on persons accustomed to water with low sulfate concentrations. However, acclimatization to high-sulfate water is such that it is not usually considered a health hazard. On the basis of taste and cathartic effect, the U.S. Environmental Protection Agency (1979) in its secondary drinking-water regulations recommended a maximum contaminant level of 250 mg/L (milligrams per liter) for sulfate.

High sulfate concentrations can limit plant uptake of calcium and disturb cationic balance within plant cells; this usually limits the use of irrigation water. Detrimental effects are dependent on calcium content, soil type, drainage, and plant variety. The California State Water Resources Control Board general guidelines for sulfate concentrations in irrigation waters (McKee and Wolf, 1963) are shown in the table that follows.

Designation (classification) for irrigation waters	Sulfate concen- tration (mg/L)	Distribution in study area (percent of wells)
Excellent-----	less than 192	24
Good-----	192-336	20
Permissible----	336-576	31
Doubtful-----	576-960	23
Unsuitable-----	greater than 960	2

Sulfate concentrations ranged from 71 to 1,100 mg/L; the mean was 397 and the median, 368 mg/L. Concentrations exceeded 250 mg/L in 67 percent of the wells sampled, and concentrations failed to meet the "good" classification for irrigation water in 56 percent of the wells.

The areal distribution of sulfate concentrations is similar to that of dissolved-solids concentrations. Sulfate concentrations of less than 250 mg/L were limited to the northeastern part of the study area. In the central part of the plain, concentrations generally were between 250 and 750 mg/L; in the western part of the study area, some concentrations exceeded 750 mg/L. Well 7N/35W-17Q6 had the highest sulfate concentration of 1,100 mg/L.



Areal distribution of sulfate, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.6 Chloride

CHLORIDE CONCENTRATIONS EXCEEDED RECOMMENDED LEVELS IN SOME SAMPLES

Chloride concentrations in about 36 percent of the samples exceeded the secondary maximum contaminant level for drinking water. Concentrations in most samples exceeded suggested levels for irrigation water.

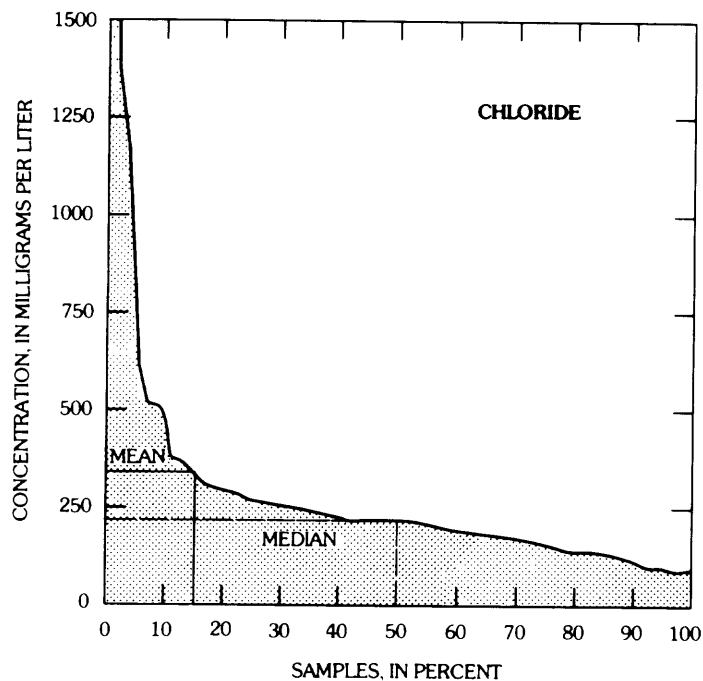
Although high chloride concentrations are not a health hazard, the U.S. Environmental Protection Agency (1979) established a secondary maximum contaminant level of 250 mg/L (milligrams per liter) for chloride in drinking water based on taste and on the association of chloride with sodium, which is a health hazard to individuals on a low-sodium diet.

Chloride in high concentrations can be toxic to plants; however, salinity usually impairs growth before chloride concentrations reach toxic levels. Unlike some constituents, chloride is not absorbed by soils, and it moves readily with water. Bouwer (1978, p. 363) suggested that chloride concentrations greater than 106 mg/L in water used for sprinkler irrigation (root and leaf watering) may cause leaf burn. In addition, Bouwer suggested chloride-concentration guidelines for plants receiving water only by roots as follows:

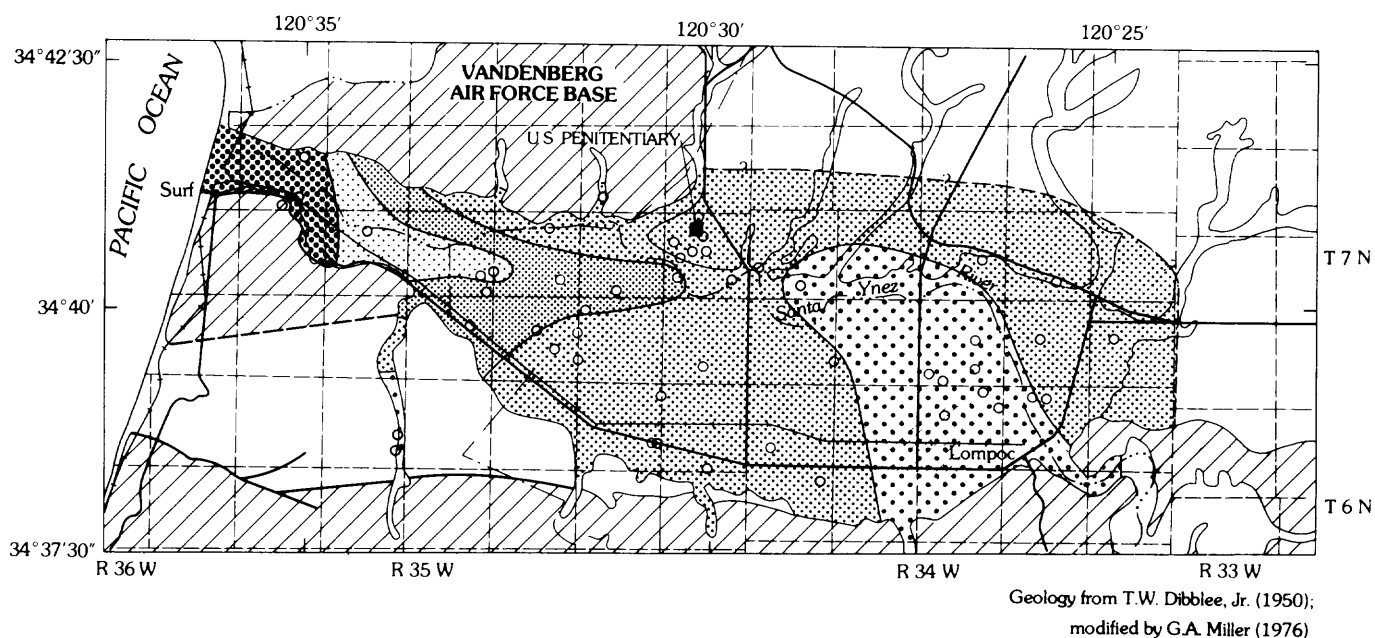
Classification (root watering only)	Chloride concentration (mg/L)	Distribution in the study area (percent)
No plant problems-----	less than 142	21
Increasing problems-----	142-355	64
Severe problems-----	greater than 355	15

Chloride concentrations ranged from 87 to 4,100 mg/L; the mean was 341 and the median, 220 mg/L. Concentrations exceeded the secondary maximum contaminant level of 250 mg/L for drinking water in about 36 percent of the wells sampled. In the eastern part of the plain near the city of Lompoc and the Santa Ynez River, concentrations generally were less than 150 mg/L; in the western part, concentrations generally exceeded 500 mg/L.

Chloride concentration in 93 percent of the wells exceeded the suggested limit (106 mg/L) for root and leaf watering. In 64 percent of the wells, chloride may cause increasing problems for root-watered plants; in 15 percent, chloride may cause severe plant problems (see table above).



Percentage of samples in which indicated concentrations were equaled or exceeded.



EXPLANATION

0 1/2 1 2 MILES
0 5 1 2 KILOMETERS

UNCONSOLIDATED DEPOSITS
CONSOLIDATED ROCKS
WELL

CHLORIDE CONCENTRATION, IN MILLIGRAMS PER LITER -- Lines dashed where approximately located, queried where doubtful
Less than 150
150-250
250-500
500-1000
More than 1000

Areal distribution of chloride, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.7 Alkalinity

ALKALINITY EXCEEDED SUGGESTED MAXIMUM LEVELS IN SOME SAMPLES

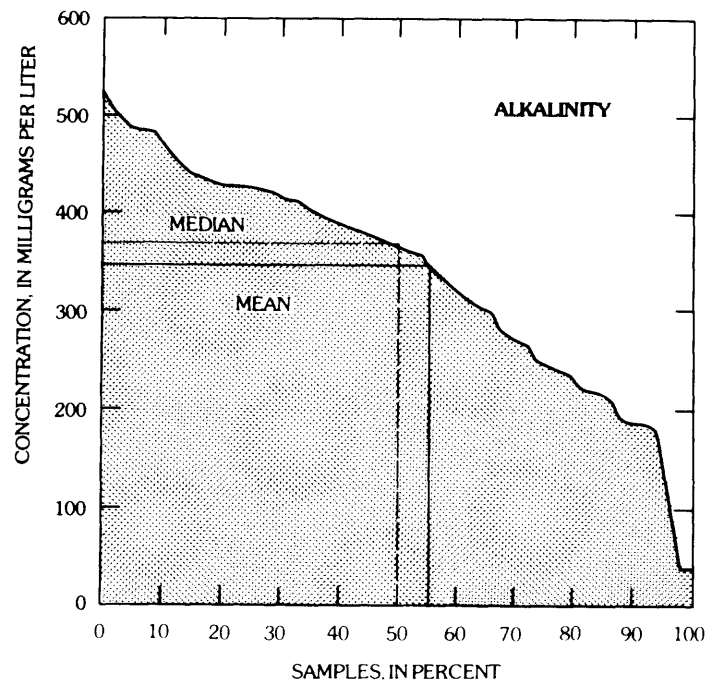
Alkalinity concentrations in 32 percent of the samples exceeded the suggested maximum concentration for drinking water; concentrations in only 24 percent met the "good" classification for irrigation water.

Alkalinity is the capacity of water to neutralize acid, and in natural waters alkalinity probably is produced exclusively by the bicarbonate and carbonate ions. Alkalinity concentration is determined by titrating with 1.600 N sulfuric acid to the phenolphthalein endpoints. Alkalinity is expressed as milligrams per liter of calcium carbonate and is the equivalent sum of bicarbonate and carbonate. Above a pH of 8.2 alkalinity is a measure of carbonate ions and below 8.2, of bicarbonate ions. Below a pH of 4.5 bicarbonate ions are converted to carbonic acid. Most ground water has a pH value ranging from 6 to 8.5 (Hem, 1985, p. 63-64).

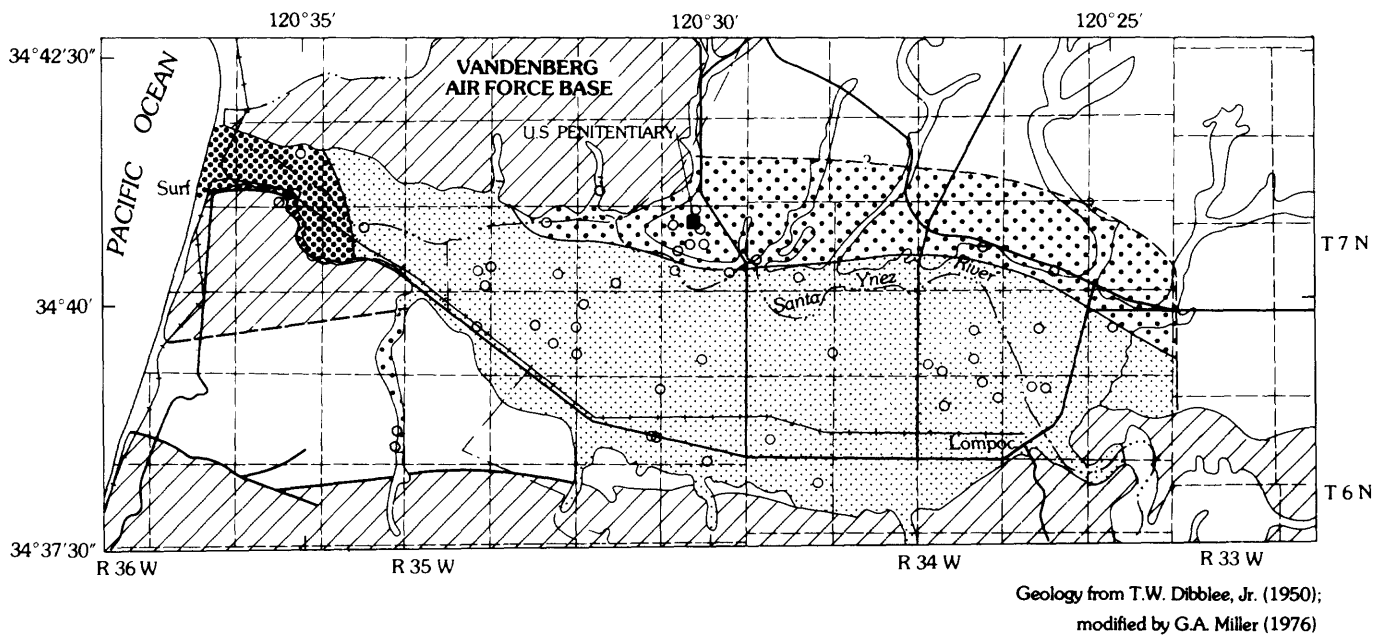
Alkalinity in high concentrations can cause eye irritation in swimmers by altering the pH of the fluids in eyes; however, it is not considered a serious health hazard. In water-distribution systems alkalinity in high concentrations causes coagulation, softening, and corrosion. The U.S. Environmental Protection Agency has not established primary or secondary contaminant levels

for alkalinity, but suggests a maximum concentration of 400 mg/L as CaCO_3 for drinking water on the basis of the buffering capacity of alkalinity (U.S. Environmental Protection Agency, 1977). Alkalinity in high concentrations (greater than 600 mg/L as CaCO_3) can be toxic to most plants, and the National Academy of Sciences and National Academy of Engineering (1973) recommended that alkalinity in irrigation waters for fruits and vegetables not exceed 250 mg/L as CaCO_3 (the upper limit of the "good" classification).

Alkalinity in the study area resulted primarily from the bicarbonate ion and ranged from 39 to 537 mg/L; the mean value was 348 and the median, 360 mg/L. Thirty-two percent of the wells sampled exceeded the suggested maximum level of 400 mg/L for drinking water. Twenty-four percent of the wells sampled met the "good" classification for irrigation water. Well 7N/35W-17G1 had a concentration of 537 mg/L, the highest in the study area. Wells near the coast tended to have the higher concentrations.



Percentage of samples in which indicated concentrations were equaled or exceeded



EXPLANATION

0 1/2 1 2 MILES
0 .5 1 2 KILOMETERS

UNCONSOLIDATED DEPOSITS
CONSOLIDATED ROCKS
WELL



ALKALINITY CONCENTRATION, IN MILLIGRAMS PER LITER - Lines dashed where approximately located, queried where doubtful
Less than 250
250-500
More than 500

Areal distribution of alkalinity, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.8 Nitrate as nitrogen

NITRATE CONCENTRATIONS WERE LOW

Nitrate concentrations were low except near the periphery of the plain. Nitrate concentrations in 98 percent of the samples met standards for drinking water and in 92 percent met the "excellent" classification for irrigation.

Water samples were analyzed for nitrate plus nitrite as nitrogen. Nitrate is the most abundant form of nitrogen found in ground water (Hem, 1985); therefore, the sum of the two chemical forms was considered to be mostly nitrate.

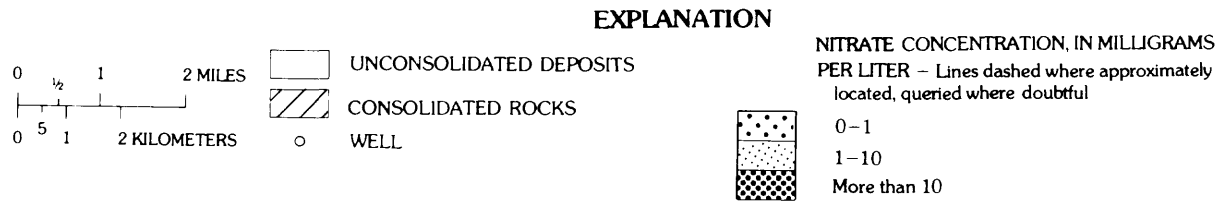
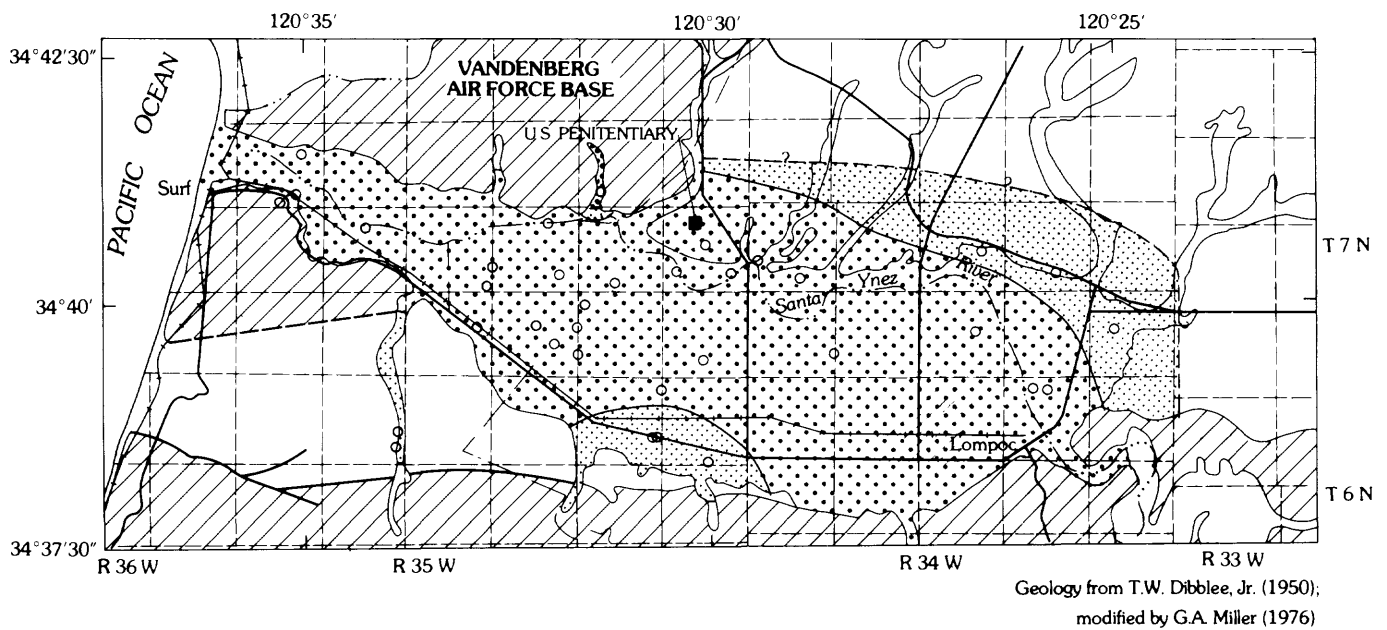
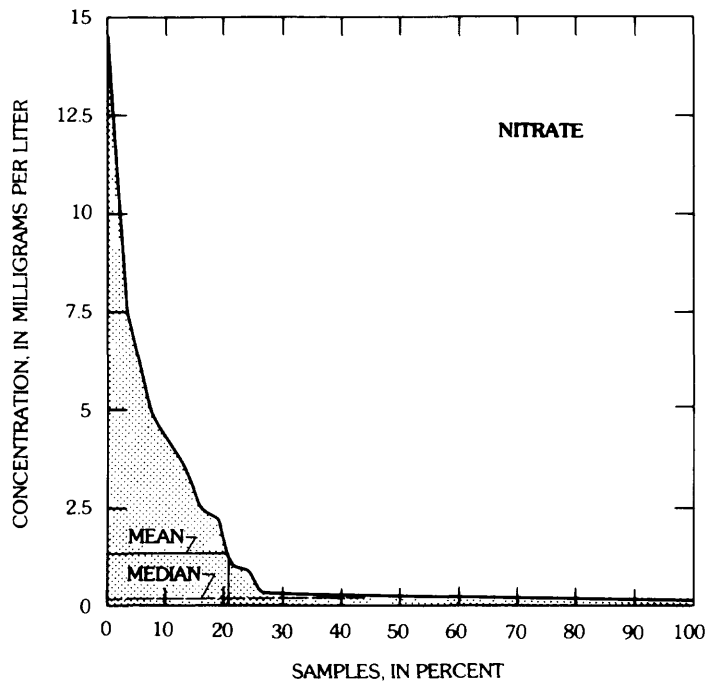
Nitrate in ground water most commonly originates from land-surface sources and is not associated with the chemical composition of the water-bearing formations. Most cases of nitrate toxicity in the United States are associated with private domestic wells that are subject to localized pollution sources, such as leachates from agricultural fertilizers, septic tanks, percolation from seepage ponds, and livestock feedlots.

Nitrate toxicity usually does not affect adults and older children, but can lead to a blood disorder known as methemoglobinemia that can be fatal in infants under 4 months old. Because of the health hazard to infants, the U.S. Environmental Protection Agency has set a primary maximum contaminant level of 10 mg/L (milligrams per liter) for nitrate as nitrogen in drinking water.

For most agricultural purposes, nitrate is considered an asset because of its value as a fertilizer. However, in high concentrations, nitrate may have adverse effects on crops such as sugar beets, apricots, grapes, citrus, and avocados. Increasing problems can be detected from concentrations greater than about 5 mg/L (less than 5 mg/L is classified "excellent"), and severe problems occur in concentrations greater than 30 mg/L (Ayers, 1977).

Nitrate concentrations ranged from less than 0.1 to 15 mg/L; the mean value was 1.33 and the median, 0.1 mg/L. Concentrations were less than 10 mg/L, the primary maximum contaminant level for drinking water, in 98 percent of the wells sampled; concentrations were less than 5.0 mg/L in 92 percent of the samples and thus met the "excellent" classification for irrigation water.

The areal distribution of nitrate concentrations shows no relation to the distribution of dissolved solids. Most of the higher nitrate concentrations were near the periphery of the plain--such as near Cebada, La Salle, Sloans, and Oak Canyons.



Areal distribution of nitrate, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.9 Fluoride

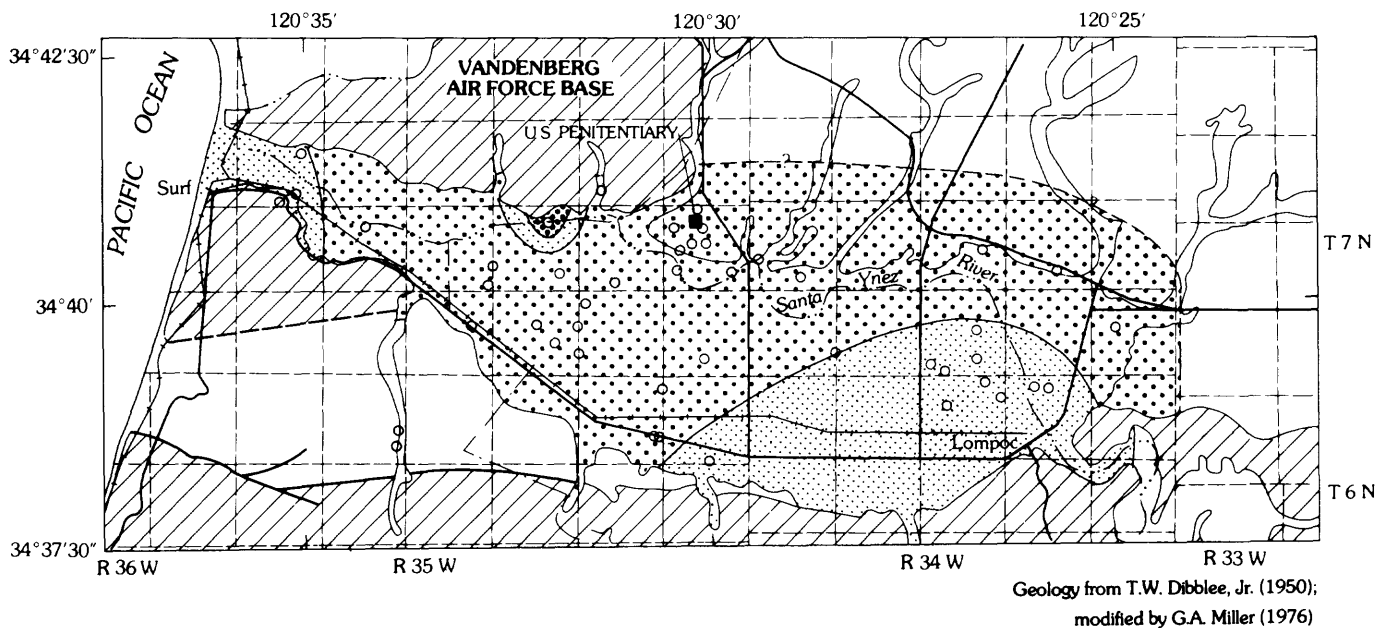
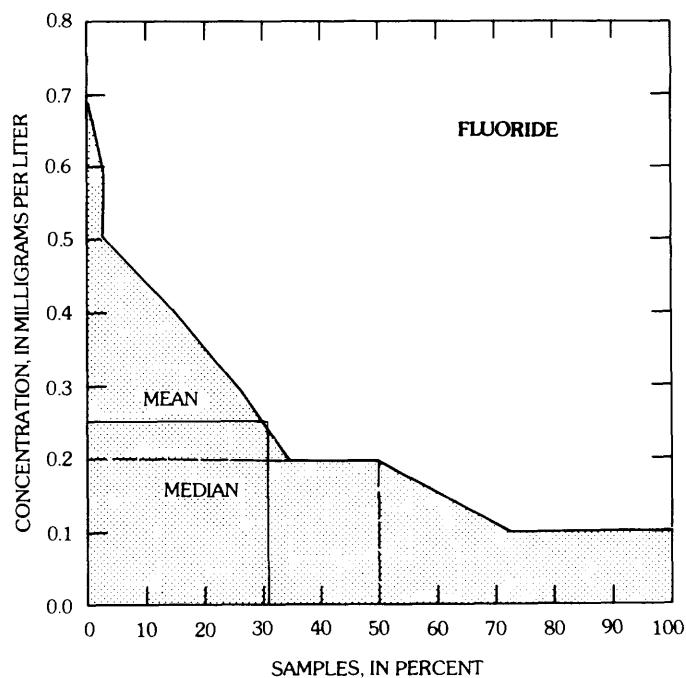
FLUORIDE CONCENTRATIONS WERE LOW

Fluoride concentrations in all samples were less than the recommended maximum levels for drinking and irrigation waters.

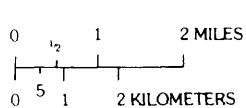
Fluoride in drinking water has some beneficial effects; however, excessive fluoride can cause dental fluorosis (mottled enamel), which increases with fluoride consumption. Because the amount of water (and therefore the amount of fluoride) an individual consumes varies directly with air temperature, the recommended maximum fluoride concentration (1.4 to 2.4 mg/L [milligrams per liter]) is adjusted according to the annual average of the maximum daily air temperature (U.S. Environmental Protection Agency, 1977). On the basis of the average maximum daily air temperature of 60.5 °F at Lompoc (National Oceanic and Atmospheric Administration, 1983), the recommended maximum fluoride concentration for the study area is 2.0 mg/L.

Soluble fluoride salt can be applied to neutral or alkaline soils without harmful effects to crop production; however, application on acidic soils can result in plant toxicity. The National Academy of Sciences and the National Academy of Engineering (1973) recommended a limit of 1.0 mg/L fluoride in irrigation water.

Fluoride concentrations in the plain ranged from less than 0.1 to 0.7 mg/L; the mean was 0.25 and the median, 0.2 mg/L. None of the wells exceeded either drinking- or irrigation-water limits. In general, the higher fluoride concentrations were in the southern part of the plain near the city of Lompoc and in the extreme western part.



EXPLANATION



- UNCONSOLIDATED DEPOSITS
- CONSOLIDATED ROCKS
- WELL

- FLUORIDE CONCENTRATION, IN MILLIGRAMS PER LITER - Lines dashed where approximately located, queried where doubtful
- 0-0.3
 - 0.3-0.5
 - More than 0.5

Areal distribution of fluoride, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.10 Iron

IRON EXCEEDED RECOMMENDED LEVEL FOR DRINKING WATER IN SOME WELLS

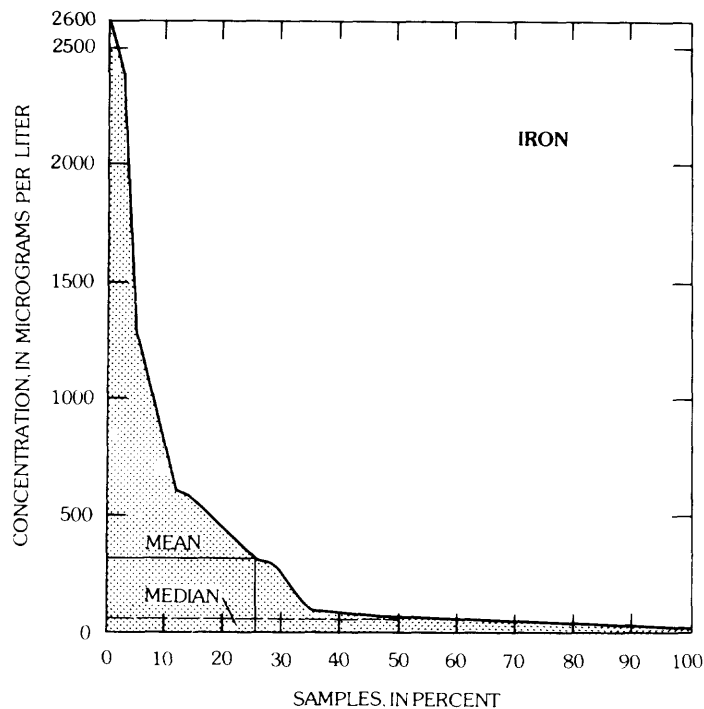
Iron concentrations in 30 percent of the samples exceeded the secondary maximum contaminant level for drinking water. No samples exceeded the recommended maximum level for irrigation waters.

High iron concentrations in water may be objectionable to users because of taste, and because of staining of plumbing fixtures, laundry, and water-distribution systems. The U.S. Environmental Protection Agency (1979), in its secondary drinking-water regulations, recommended a limit of 300 $\mu\text{g/L}$ (micrograms per liter) in public water supplies.

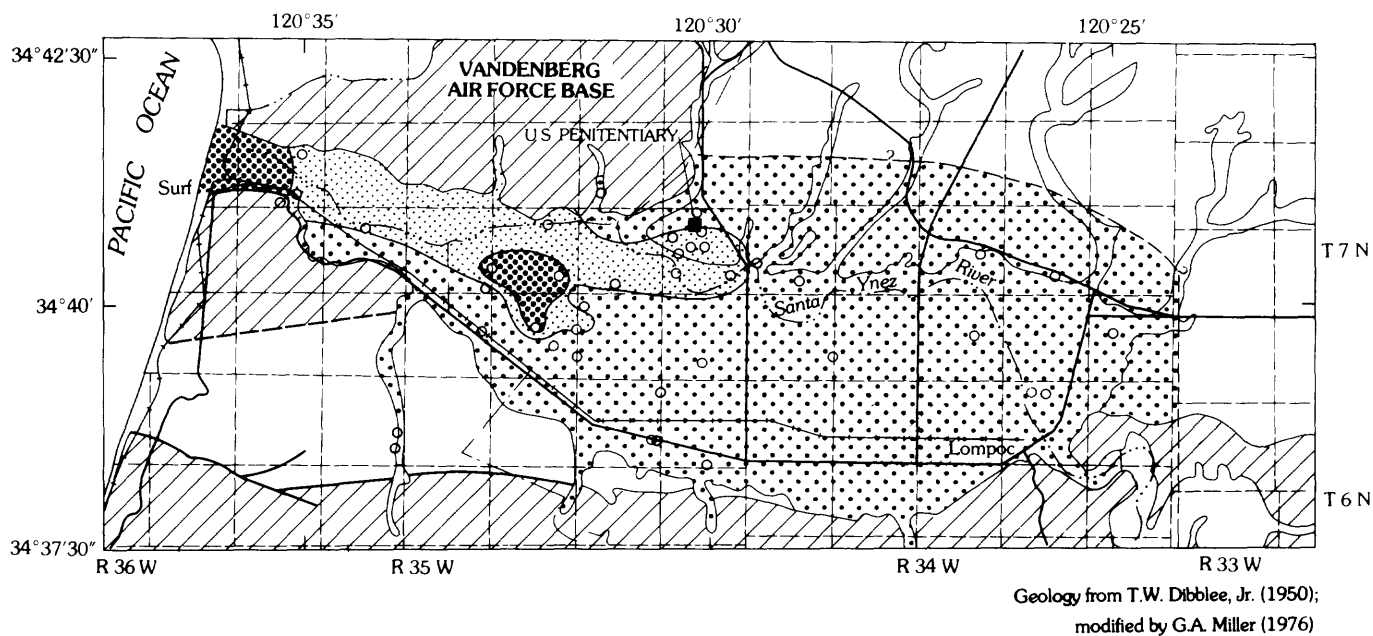
Iron is sometimes used in irrigation waters to fight plant chlorosis. The National Academy of Sciences and

National Academy of Engineering (1973) recommended a maximum iron concentration of 5,000 $\mu\text{g/L}$ for irrigation waters.

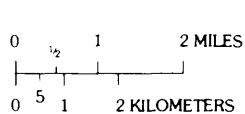
The concentration of iron in samples ranged from less than 3 to 2,600 $\mu\text{g/L}$; the mean value was 320 $\mu\text{g/L}$ and the median, 60 $\mu\text{g/L}$. Iron concentration exceeded 300 $\mu\text{g/L}$ in about 30 percent of the samples (13 wells). None of the wells sampled exceeded the recommended maximum level for irrigation waters. In general, the higher concentrations were in the western part of the plain along the Santa Ynez River.



Percentage of samples in which indicated concentrations were equaled or exceeded



EXPLANATION



- UNCONSOLIDATED DEPOSITS
- CONSOLIDATED ROCKS
- WELL

- IRON CONCENTRATION, IN MICROGRAMS PER LITER
- Lines dashed where approximately located;
queried where doubtful
- Less than 300
 - 300-750
 - More than 750

Areal distribution of iron, 1983.

5.0 CHEMICAL QUALITY OF WATER IN THE MAIN WATER-BEARING ZONE--Continued

5.11 Boron

BORON CONCENTRATIONS GENERALLY ARE NOT HARMFUL

Boron concentrations in 14 percent of the samples exceeded the recommended level of 750 micrograms per liter for sensitive plants; however, the levels probably would not be injurious to most crops grown on the plain.

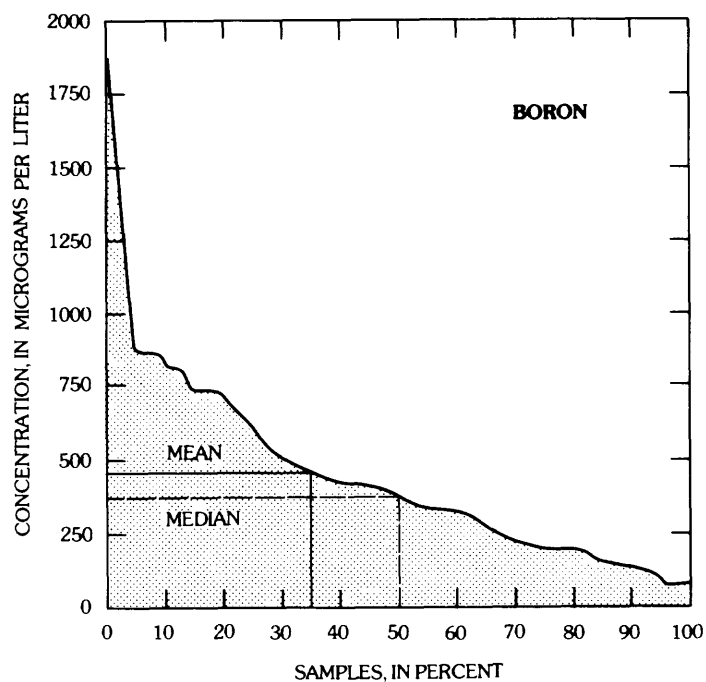
Boron is not considered to be an essential element for humans, and there are no Federal regulations for boron in drinking water.

In irrigation water, boron (in concentrations up to 500 $\mu\text{g/L}$ [micrograms per liter]) is considered an essential micronutrient; however, concentrations greater than 750 $\mu\text{g/L}$ can be toxic to some sensitive plants. Water containing boron in concentrations greater than 4,000 $\mu\text{g/L}$ is considered unsatisfactory, if used continuously, for almost all crops.

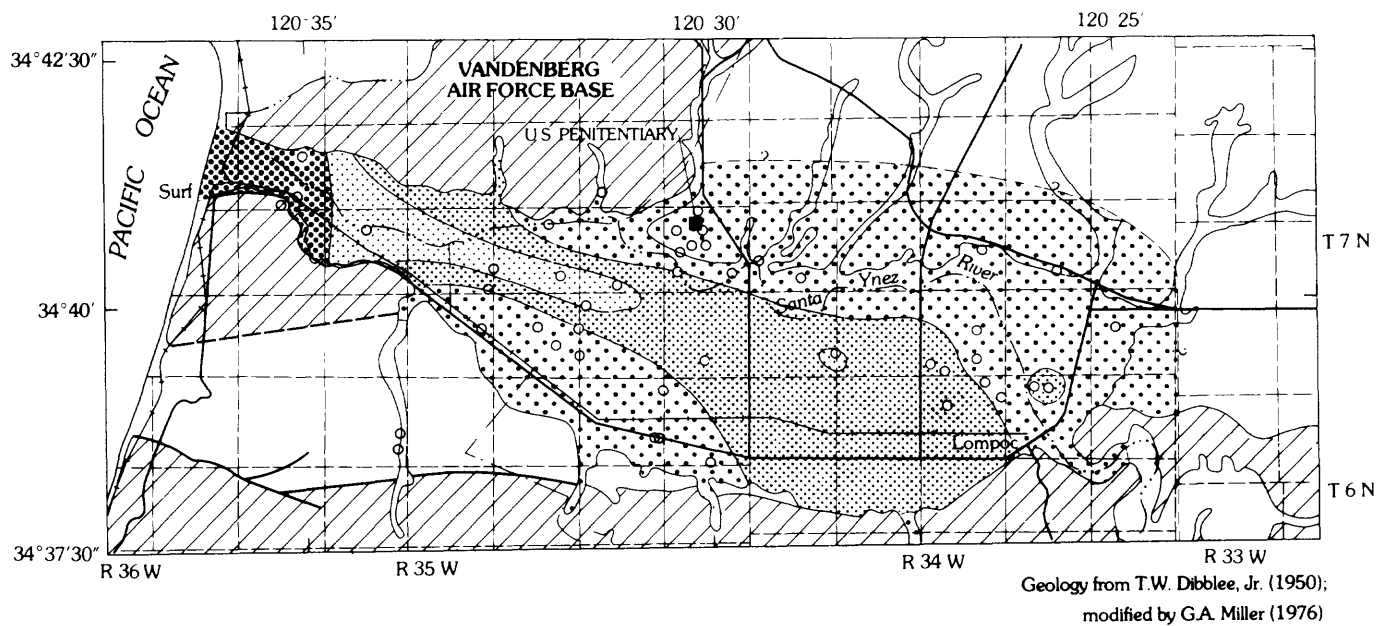
Crops have been classified by Miller (1976) into three categories of boron tolerance: sensitive--toxicities of 750 $\mu\text{g/L}$ or less; semitolerant--toxicities of 750 to 2,000 $\mu\text{g/L}$; and tolerant--toxicities of 2,000 to 4,000 $\mu\text{g/L}$. Shown are the tolerance classifications (modified from Miller, 1976) of selected crops grown on the Lompoc plain; crops are listed in decreasing order of tolerance in each group.

Tolerant (4,000 to 2,000 $\mu\text{g/L}$)	Semitolerant (2,000 to 750 $\mu\text{g/L}$)	Sensitive (750 to 0 $\mu\text{g/L}$)
Sugar beet Alfalfa Cabbage Lettuce Carrot	Barley Wheat Oat Garbanzo bean Lima bean	Walnut Grapes

Boron concentrations ranged from 70 to 1,800 $\mu\text{g/L}$; the mean value was 459 $\mu\text{g/L}$ and the median, 390 $\mu\text{g/L}$. Concentrations exceeded 750 $\mu\text{g/L}$ in 14 percent of the wells sampled. Concentrations were high (greater than 750 $\mu\text{g/L}$) along the Santa Ynez River near the coast and generally increased from east to west. Well 7N/35W-17Q6 had the highest concentration of 1,800 $\mu\text{g/L}$. Because most crops grown on the plain have tolerances of 750 to 4,000 $\mu\text{g/L}$, boron probably is not injurious to them.



Percentage of samples in which indicated concentrations were equaled or exceeded.



EXPLANATION

0 1/2 1 2 MILES
0 5 1 2 KILOMETERS

UNCONSOLIDATED DEPOSITS
CONSOLIDATED ROCKS
WELL

BORON CONCENTRATION, IN MICROGRAMS PER LITER - Lines dashed where approximately located. queried where doubtful

Less than 500
500 - 750
750 - 1 000
More than 1 000

Areal distribution of boron, 1983.

6.0 IRRIGATION WATER CLASSIFICATION

6.1 Sodium Hazard and Salinity Hazard

FOR IRRIGATION, MOST GROUND WATER IN THE PLAIN HAD A LOW SODIUM HAZARD AND A HIGH SALINITY HAZARD

Eighty-eight percent of the samples met the "low" sodium-hazard classification; all samples met the "high" or "very high" salinity-hazard classifications.

A method widely used for evaluating irrigation water is shown on the facing page (U.S. Salinity Laboratory, 1954). The method uses a diagram that is divided into 16 areas to define the degree of salinity (which is related to dissolved-solids concentration) and undesirable ion-exchange effects for a particular water. This diagram classifies irrigation water by its sodium hazard and salinity hazard. Sodium hazard is expressed in terms of the SAR (sodium-adsorption ratio) by the equation:

$$SAR = \frac{Na^{+1}}{\sqrt{\frac{Ca^{+2} + Mg^{+2}}{2}}},$$

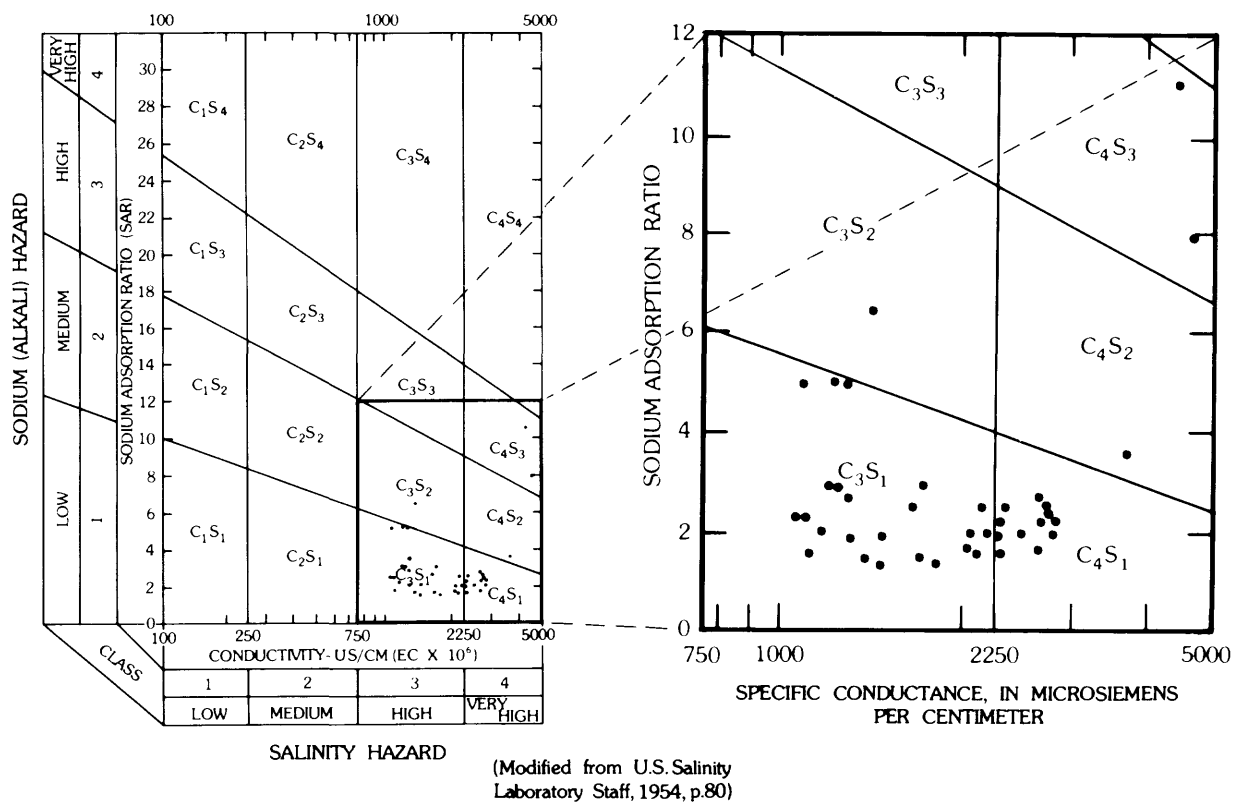
where Na is the concentration of sodium; Ca, the concentration of calcium; and Mg, the concentration of magnesium (all concentrations in milliequivalents per liter). Salinity hazard is expressed in terms of specific conductance in microsiemens per centimeter.

Water in the C_1S_1 classification (diagram on facing page) can be used on most soils and crops without adverse effects. As salinity increases, sodium

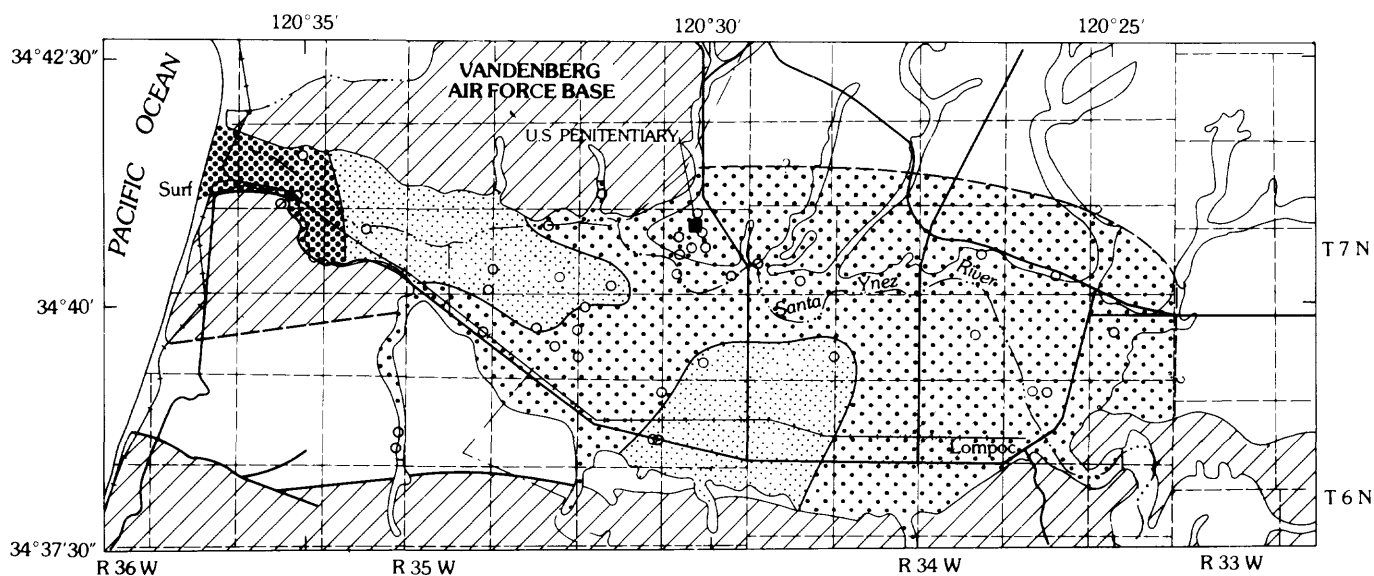
becomes less exchangeable, and more leaching will be required to prevent salinity damage to crops. Water in the C_4S_1 classification can be tolerated by plants if good drainage is provided to prevent salinity buildup.

High SAR values are associated with sodium concentrations that are high in relation to calcium and magnesium concentrations; these conditions decrease the permeability of the soil. Poor permeability makes it difficult to supply water to the crop and causes waterlogging, oxygen and nutritional problems, and soil diseases, and encourages weeds.

Sixty percent of the wells sampled contained water classified C_3S_1 (high salinity, low sodium hazard), and 28 percent contained water classified C_4S_1 (very high salinity, low sodium hazard). Thus 88 percent of the wells sampled contained water that is considered to be low in sodium hazard but high to very high in salinity hazard. Wells with these classifications are located throughout the plain--except in the extreme western part of the study area near the coast, where water was generally very high in salinity hazard and high to very high in sodium hazard.



Irrigation water classification based on sodium hazard and salinity hazard.



Geology from T.W. Dibblee, Jr. (1950);
modified by G.A. Miller (1976)

EXPLANATION

0 1 2 MILES
0 1 2 KILOMETERS

UNCONSOLIDATED DEPOSITS
CONSOLIDATED ROCKS
WELL

IRRIGATION WATER CLASSIFICATION— (Classes defined in text) Lines dashed where approximately located, queried where doubtful



C₃S₁ High salinity-low sodium
C₄S₁ Very high salinity-low sodium
C₄S₃ and C₄S₄ very high salinity-high to very high sodium

Areal distribution of irrigation water classes.

6.0 IRRIGATION WATER CLASSIFICATION--Continued

6.2 Sodium Carbonate Residual

POTENTIAL FOR INCREASE IN SODIUM HAZARD IS LOW

All wells sampled had negative residual-sodium-carbonate values, and thus the potential for an increase in sodium hazard is very low.

High concentrations of bicarbonate ions in water can cause calcium and magnesium to precipitate as carbonates, thereby increasing the proportion of sodium and, consequently, increasing the sodium hazard. Eaton (1950) expressed the bicarbonate value of water in terms of RSC (residual sodium carbonate). RSC is an estimate of the potential increase in sodium hazard and can be calculated by the following equation:

$$\text{RSC} = (\text{CO}_3^{-2} + \text{HCO}_3^{-1}) - (\text{Ca}^{+2} + \text{Mg}^{+2}),$$

where CO_3 is concentration of carbonate; HCO_3 , the concentration of bicarbonate; Ca, the concentration of calcium; and Mg, the concentration of magnesium (all concentrations in milliequivalents per liter [meq/L]) (Eaton, 1950).

Water with an RSC value less than 1.25 meq/L is considered safe for most plants and soils under most conditions and will not change the sodium hazard; water with an RSC value between 1.25 and 2.5 meq/L is marginal, and the potential for an increase in the sodium hazard exists. Marginal water can be used if good management practices are followed. Water with an RSC value greater than 7.5 meq/L will increase the sodium hazard and is unsuitable for irrigation.

All wells sampled had negative RSC values. Values ranged from -0.68 to -33.52. A negative RSC value, which means that the combined concentration of carbonate and bicarbonate is less than that of calcium and magnesium, indicates a very low potential for sodium hazard to increase.

**Concentrations of residual sodium carbonate in
samples from selected wells**

[meq/L, millequivalents per liter; --, no data]

Well	Residual sodium carbonate (meq/L)	Well	Residual sodium carbonate (meq/L)
6N/34W-5H5	--	7N/34W-34B1	-7.09
-9A4	-6.47	-34F6	-10.42
-9A5	-7.20	-35C4	-8.09
7N/34W-19C1	-13.11	-35C6	-9.60
-19C2	-.80	7N/35W-13N2	-2.74
-19E1	-2.43	-17G1	-6.44
-19E2	-3.16	-17K20	-17.29
-19F1	-1.57	-17Q6	-33.52
-19F2	-.68	-21G2	-11.95
-19J1	-2.79	-22J2	--
-19J6	-2.58	-22J3	-16.49
-19N2	-8.79	-22R1	-13.05
-20K6	-4.77	-23B2	-.74
-20M2	-4.83	7N/35W-23K1	-14.37
-22J6	-6.51	-24P3	-12.01
-23L2	-2.99	-25D3	-12.55
-25F3	-7.67	-26F4	-14.98
-26F6	--	-25H1	-13.73
-27G4	-7.42	-26J6	-11.53
-27N5	-13.72	-26K1	-8.56
7N/34W-27P5	-9.28	-27H2	-11.17
-27Q2	-7.14	-33J2	-3.63
-29J1	-13.23	-33J4	-4.57
-30L5	-16.09	-36A2	-5.39
-31Q4	-9.38	-35J6	-13.40
-32P1	--	-36J8	-13.72
-34A4	-6.67		

7.0 CHANGES IN WATER QUALITY IN THE MAIN WATER-BEARING ZONE

GROUND-WATER QUALITY CHANGED SIGNIFICANTLY BETWEEN 1972 AND 1983

A comparison of dissolved-solids concentrations in 1972 and 1983 samples indicates that ground-water quality in most of the plain degraded significantly during that period.

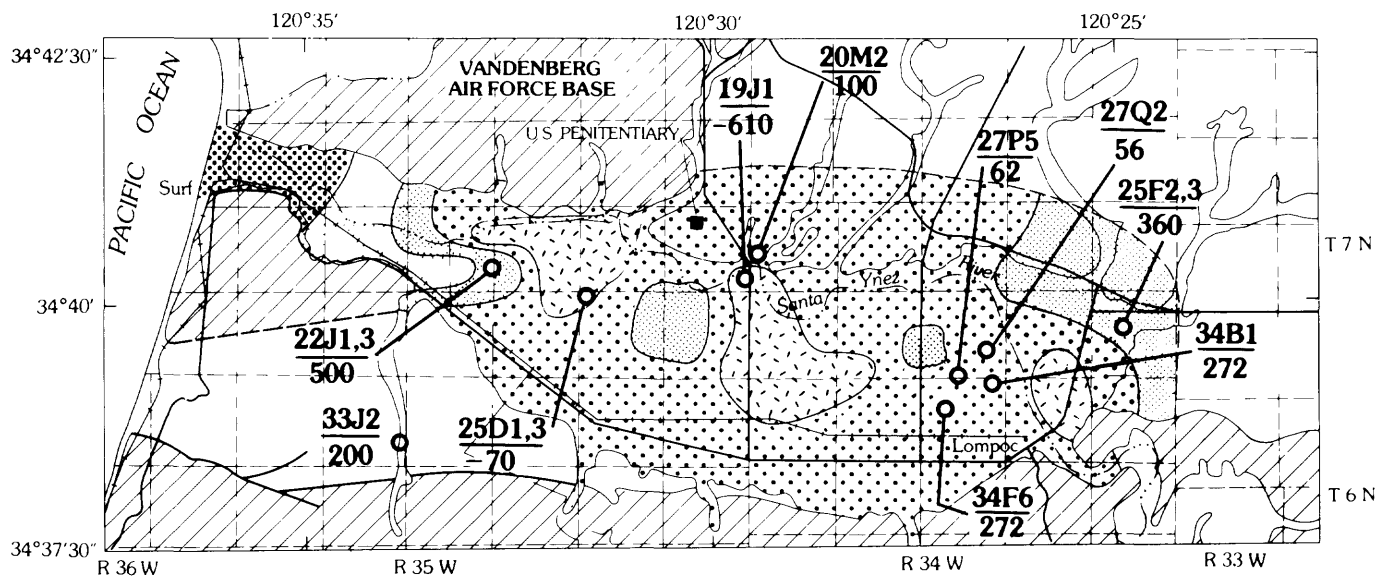
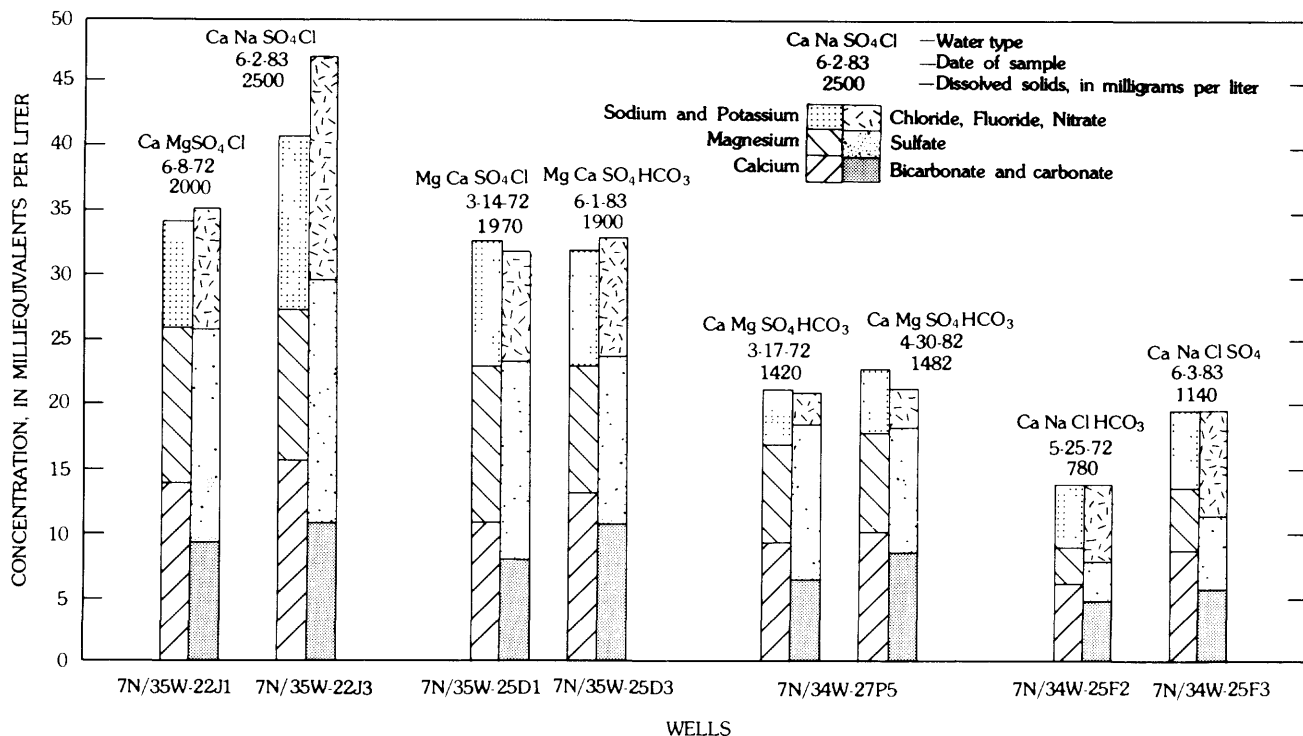
Prior to this study, the last comprehensive ground-water-quality study was completed by Miller (1976) on the basis of data collected in 1972. Miller noted that ground-water quality in the plain had deteriorated during the past several decades. One of the objectives of this study was to determine if the ground-water quality in the plain had continued to degrade from 1972 to 1983. To meet this objective an attempt was made to sample wells in 1983 that had been sampled in 1972 and compare results. Unfortunately, this could not be done because most of the wells sampled in 1972 have since been destroyed or abandoned. Because only a few wells could be resampled, areal maps of dissolved-solids concentrations for the two periods were compared to define the changes in ground-water quality from 1972 to 1983.

The change map for the period 1972-83, on the facing page, indicates that dissolved-solids concentrations over most of the plain increased. Dissolved-solids concentrations in 64 percent of the area increased by 0-250 mg/L (milligrams per liter); 14 percent, 250-500 mg/L; 5 percent, 500-1,000 mg/L; and 4 percent by more than 1,000 mg/L. Dissolved-solids concentrations in 13 percent of the area decreased. Overall, the average areal change was an increase of about 187 mg/L for the period

1972-83, or about 16 mg/L per year. If dissolved-solids concentration continues to increase, agricultural practices in the future will be affected. Locally, dissolved-solids concentrations increased or decreased at different rates. The largest increases were in the western part of the plain near the coast. The decreases in dissolved-solids concentration occurred in several large areas in the central part of the plain.

Bar graphs showing the chemical composition of ground water from selected wells sampled in 1972 and in 1982-83 are shown on the facing page. The dissolved-solids concentration in 1982-83 for three of the four wells (or wells nearby) was higher than in 1972; one well showed a slight decrease.

Analyses show that although the dissolved-solids concentrations changed, the water type remained virtually the same. The general increase in dissolved-solids concentration with no change in water type suggests a nonspecific process as the cause of the increase. Such a process is evaporation, which concentrates dissolved solids in agricultural return flow. Decreases in dissolved-solids concentration that occurred in some areas may be attributed to better quality recharge water, changing water uses, and (or) changing farming practices.



Areal distribution of change in dissolved-solids concentration between 1972 and 1983.

8.0 SUMMARY AND CONCLUSIONS

Ground water is the main source of water in the Lompoc plain. Most of the water pumped is from the main water-bearing zone, the lower member of the younger alluvium. Natural recharge to this zone is from infiltration of streamflow and precipitation, and from ground-water underflow. Irrigation return flows and treated sewage effluent also are considered recharge. Direction of ground-water flow generally corresponds to surface flow. Throughout the central part of the plain, hydraulic heads are higher in the shallow zone than in the main water-bearing zone; this causes ground water to flow from the shallow zone to the main water-bearing zone.

Long-term ground-water levels have not changed significantly since the 1940's. Seasonally, ground-water levels fluctuate in response to pumping and natural recharge. Between spring and autumn 1982, military and agricultural pumping in the central part of the plain lowered ground-water levels about 15 feet. Ground-water levels completely recovered by spring 1983.

Dissolved-solids concentrations in all samples exceeded the U.S. Environmental Protection Agency secondary maximum contaminant level of 500 mg/L (milligrams per liter) for drinking water. Some wells sampled yielded water with concentrations of one or more chemical constituents--sodium, chloride, nitrate, and iron--that equaled or exceeded primary or secondary maximum contaminant levels for drinking water.

Predominant ions in ground water in the study area generally were calcium, magnesium, sulfate, and bicarbonate--except in the western part, where sodium and chloride were the predominant dissolved ions. Throughout the plain, hardness values generally exceeded 180 mg/L; such water is designated "very hard." The areal distribution of dissolved-solids, hardness, chloride, and sulfate concentrations indicates that ground water deteriorates in quality from east to west.

Concentrations of several constituents in samples from some wells exceeded recommended levels for irrigation water. Eighty percent of the wells sampled contained water that is low in sodium hazard, but high to very high in salinity hazard. Such water can be tolerated by plants if adequate drainage is provided to prevent salinity buildup.

Between 1972 and 1983, dissolved-solids concentrations increased by an average of about 175 mg/L; this is an average annual increase of about 16 mg/L. The largest increases, greater than 1,000 mg/L, occurred in the extreme western part of the plain. If dissolved-solids concentration, or salinity, continues to increase, agricultural practices in the future will be affected. Decreases occurred in the central part. These decreases may be attributable to better quality recharge, changing water use, and (or) changing farming practices.

SUMMARY AND CONCLUSIONS

- **Ground-water is the main source of water in the Lompoc plain**
- **Most pumpage is from the lower, main water-bearing zone**
- **The sources of natural recharge are the infiltration of streamflow, precipitation, and ground-water underflow**
- **Ground-water levels in the central part of the plain declined seasonally owing to military and agricultural pumping**
- **Long-term ground-water levels have not changed significantly since the 1940's**
- **The predominant ions in ground water generally were calcium, magnesium, sulfate, and bicarbonate in the eastern part of the plain and sodium and chloride in the western part**
- **Constituents in some samples exceeded recommended levels for drinking and irrigation waters**
- **Ground-water quality deteriorates from east to west**
- **Ground-water quality in most of the plain degraded significantly between 1972 and 1983**
- **Increasing dissolved-solids concentration, or salinity, may necessitate changes in future agricultural practices**

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10.0 DATA--GROUND-WATER LEVELS IN THE MAIN WATER-BEARING ZONE

[Date given is the month and day sample was collected. Water level is in feet above sea level.
See section 3.1 for location of wells]

Well No.	Spring 1982		Autumn 1982		Spring 1983	
	Date	Water level	Date	Water level	Date	Water level
6N/34W-1G2	03-26	99.7	09-24	97.7	04-26	101.2
6N/34W-1P1	03-30	110.62	--	--	04-07	110.03
6N/34W-1R1	02-23	116.7	09-24	113.1	04-26	119.1
6N/34W-2A6	01-26	91.3	09-24	88.2	04-26	92.9
6N/34W-4G4	01-29	52.2	10-27	49.9	04-27	54.9
6N/34W-6C1	04-01	40.43	--	--	04-08	49.64
7N/33W-17N2	03-30	82.00	--	--	04-07	88.47
7N/33W-19D1	03-30	76.55	--	--	04-07	76.65
7N/34W-12E1	03-31	65.42	--	--	04-08	65.64
7N/34W-14F3	03-31	52.19	--	--	04-07	52.86
7N/34W-15D1	04-05	54.04	--	--	04-11	53.18
7N/34W-15D2	04-05	54.36	--	--	04-11	52.37
7N/34W-15E1	04-05	52.48	--	--	04-11	51.99
7N/34W-15P1	04-01	53.45	--	--	04-08	53.92
7N/34W-19C1	--	--	08-06	41.41	04-05	44.25
7N/34W-19C2	--	--	08-09	36.60	04-05	42.70
7N/34W-19E1	--	--	08-08	31.96	04-05	36.60
7N/34W-19E2	--	--	08-25	31.90	04-05	36.10
7N/34W-19F1	03-08	30.67	08-09	29.94	04-05	42.08
7N/34W-19F2	--	--	08-08	30.58	04-05	40.30
7N/34W-19J3	01-28	35.40	06-28	23.83	--	--
7N/34W-20K4	01-28	45.08	10-27	41.84	05-25	50.25
7N/34W-20M2	--	--	10-27	37.98	05-26	46.00
7N/34W-22F2	03-28	48.90	10-27	46.4	03-29	51.8
7N/34W-22J6	03-31	46.25	--	--	04-14	49.61
7N/34W-23L1	01-28	58.4	10-27	55.7	04-27	60.0
7N/34W-23Q2	03-27	57.2	10-27	54.3	04-27	58.7
7N/34W-24N1	04-06	59.23	--	--	04-07	59.88
7N/34W-25D1	03-27	58.3	10-27	54.3	04-27	60.1
7N/34W-25F1	03-27	58.6	10-27	55.0	04-27	60.2
7N/34W-25P1	04-27	61.9	10-28	60.7	05-25	68.6
7N/34W-26B4	03-27	58.9	10-27	55.9	04-27	61.2
7N/34W-26F7	03-27	59.0	10-27	56.5	04-27	61.0
7N/34W-26H2	03-27	59.9	10-28	57.4	03-28	64.8
7N/34W-26H3	03-30	59.34	10-28	56.5	04-07	60.56
7N/34W-26Q5	03-27	58.0	10-27	53.4	04-26	67.1
7N/34W-27F4	04-01	53.18	10-27	47.5	04-08	60.92
7N/34W-27L1	04-16	54.5	10-20	43.5	05-09	61.5
7N/34W-27P5	04-28	50.8	10-27	44.8	04-27	53.8
7N/34W-29E4	04-01	44.07	--	--	04-08	45.88
7N/34W-29R1	04-01	46.53	--	--	04-08	48.71
7N/34W-30L3	04-01	38.25	--	--	04-08	45.05
7N/34W-31C2	04-02	41.21	--	--	04-11	42.88
7N/34W-31C3	04-02	46.85	--	--	04-08	51.50
7N/34W-34A5	03-26	71.5	10-27	62.5	04-27	76.5
7N/34W-34B1	04-28	52.3	10-27	44.3	04-27	58.3
7N/34W-34F6	06-22	42.0	10-27	30.0	03-24	36.0
7N/34W-34R1	03-27	60.4	10-27	60.0	03-28	60.8
7N/34W-35F2	03-30	83.06	--	--	04-07	84.55
7N/34W-35K9	03-26	80.5	10-27	79.7	04-27	82.76

10.0 DATA--GROUND-WATER LEVELS IN THE MAIN WATER-BEARING ZONE--Continued

Well No.	Spring 1982		Autumn 1982		Spring 1983	
	Date	Water level	Date	Water level	Date	Water level
7N/35W-13N2	06-23	35.92	10-04	35.42	04-06	56.05
7N/35W-17G1	06-23	5.74	10-26	4.26	05-25	4.01
7N/35W-17K1	01-26	6.24	10-26	7.35	05-25	7.15
7N/35W-17K20	06-23	7.38	10-26	6.36	05-25	6.62
7N/35W-17M1	04-02	6.38	--	--	04-08	5.93
7N/35W-17Q6	06-23	9.47	10-26	8.72	05-25	9.22
7N/35W-18H1	04-02	5.02	--	--	04-08	4.03
7N/35W-18J2	04-02	4.40	--	--	04-08	4.57
7N/35W-21G2	06-20	6.45	10-26	7.30	05-25	9.86
7N/35W-22J1	04-06	18.75	--	--	04-14	19.77
7N/35W-22L1	01-26	13.60	10-26	11.27	05-25	13.96
7N/35W-22M1	01-26	20.70	10-26	16.51	05-25	20.53
7N/35W-23E2	04-02	20.73	--	--	04-14	20.40
7N/35W-23E4	04-02	23.43	--	--	04-14	26.47
7N/35W-23J5	04-05	27.25	--	--	04-14	28.56
7N/35W-24J4	04-05	27.23	--	--	04-15	26.94
7N/35W-24K5	04-05	29.33	--	--	04-14	31.87
7N/35W-25F5	--	--	--	--	04-15	28.64
7N/35W-26F4	04-02	24.57	--	--	04-14	21.63
7N/35W-27F1	01-26	18.79	10-26	14.51	05-25	18.64
7N/35W-27H1	01-26	19.51	10-26	14.16	05-25	17.21
7N/35W-27P1	01-26	34.77	10-26	33.27	05-25	35.08
7N/35W-33J1	01-26	49.49	10-26	46.14	05-25	51.10
7N/35W-33J2	06-07	43.53	10-26	41.11	05-25	45.60
7N/35W-33J3	01-26	87.66	10-26	86.85	05-25	91.29

11.0 DATA--CHEMICAL ANALYSES OF GROUND WATER FROM THE MAIN WATER-BEARING ZONE

[Depth of well in feet below land surface. $\mu\text{S}/\text{cm}$, microsiemens per centimeter at 25 °C; °C, degrees Celsius; mg/L, milligrams per liter; $\mu\text{g}/\text{L}$, micrograms per liter; <, actual value is less than value shown. See Section 3.1 for location of wells. Analysis for each well shown on one line on three consecutive pages]

Well No.	Date	Time	Depth of well, total (feet)	Specific conductance ($\mu\text{S}/\text{cm}$)	pH (units)	Temperature (°C)	Hardness (mg/L as CaCO_3)	Hardness, noncarbonate (mg/L as CaCO_3)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)
6N/34W-5H5	06-01-83	1200	--	2,280	7.4	14.0	--	--	--	--
6N/34W-9A4	05-31-83	1600	120	1,360	7.0	17.0	700	320	160	74
6N/34W-9A5	06-03-83	1500	553	1,780	7.1	18.0	770	360	170	84
7N/34W-19C1	08-09-82	1000	138	2,730	7.3	19.0	1,100	660	280	94
7N/34W-19C2	04-07-83	--	158	1,080	8.3	--	260	40	56	30
7N/34W-19E1	08-09-82	1600	158	1,250	7.5	20.5	330	120	80	32
7N/34W-19E2	04-08-83	--	158	1,240	7.8	--	400	160	99	36
7N/34W-19F1	01-11-84	0845	200	1,060	7.6	19.0	300	79	83	23
7N/34W-19F2	04-07-83	--	158	1,220	8.1	--	260	34	56	29
7N/34W-19J1	06-30-82	0930	166	1,290	7.4	19.5	390	140	110	28
7N/34W-19J6	07-18-83	1030	260	1,210	7.4	20.5	370	130	110	23
7N/34W-19N2	06-01-83	1020	--	2,150	7.4	18.0	820	440	190	84
7N/34W-20K6	07-19-83	1045	210	1,300	7.3	20.0	520	240	150	35
7N/34W-20M2	07-19-83	1000	177	1,700	7.1	20.5	550	240	160	37
7N/34W-22J6	06-03-82	0830	135	1,460	7.2	19.5	510	210	130	46
7N/34W-23L2	06-03-83	0930	--	1,160	7.0	20.0	340	150	85	31
7N/34W-25F3	06-03-83	1130	--	1,630	7.6	23.0	630	380	160	57
7N/34W-26F6	06-03-83	1200	--	2,250	7.3	19.0	--	--	--	--
7N/34W-27G4	06-03-83	0750	204	1,680	7.6	16.0	690	370	150	77
7N/34W-27N5 ¹	04-30-82	--	200	2,075	7.3	17	1,084	687	246	114
7N/34W-27P5 ¹	04-30-82	--	172	1,756	7.3	18	856	464	193	91
7N/34W-27Q2 ¹	02-08-82	--	190	1,392	7.3	16.0	668	358	147	73
7N/34W-29J1	06-02-83	1200	182	2,250	7.2	18.0	1,100	660	240	110
7N/34W-30L5	06-01-83	0745	--	2,600	7.2	17.0	1,300	810	280	140
7N/34W-31Q4	06-01-83	1740	111	2,250	7.3	12.0	960	470	170	130
7N/34W-32P1	06-01-83	1630	--	2,480	7.2	14.0	--	--	--	--
7N/34W-34A4 ¹	02-05-82	--	176	1,357	7.4	16.0	610	335	135	66
7N/34W-34B1 ¹	02-05-82	--	195	1,402	7.3	17	656	355	149	69
7N/34W-34F6 ¹	04-30-82	--	148	1,915	7.3	17.0	932	520	214	97
7N/34W-35C4	06-03-83	1205	122	2,100	7.8	20.0	800	410	170	90
7N/34W-35C6	06-03-83	1200	122	2,030	7.3	20.0	840	480	180	95
7N/35W-13N2	06-04-83	--	44	1,280	6.2	16.0	180	140	31	24
7N/35W-17G1	06-20-82	1325	70	4,425	7.5	19.5	860	320	130	130
7N/35W-17K20	06-20-82	1223	126	4,650	7.3	18.0	1,200	870	200	170
7N/35W-17Q6	06-20-82	1245	87	12,700	7.5	19.0	2,200	1,700	280	360
7N/35W-21G2	10-04-82	1120	180	2,600	7.7	19.0	1,100	600	230	120
7N/35W-22J2	06-02-83	1545	179	3,575	7.5	18.0	--	--	--	--
7N/35W-22J3	06-02-83	1540	177	3,600	7.4	18.0	1,300	830	300	140
7N/35W-22R1	06-02-83	1520	179	2,680	7.5	18.5	1,100	650	240	120
7N/35W-23B2	07-06-83	0950	80	1,400	7.5	16.5	220	37	54	20
7N/35W-23K1	06-02-83	1640	--	2,600	7.2	18.0	1,200	720	250	130
7N/35W-24P3	06-01-83	1330	195	2,300	7.3	18.0	1,000	600	230	110
7N/35W-25D3	06-01-83	1145	194	2,680	7.4	17.5	1,100	630	250	120
7N/35W-26F4	08-30-83	1640	190	2,730	7.5	17.0	1,200	750	240	140
7N/35W-26H1	06-01-83	1300	177	2,240	7.2	18.0	1,100	690	250	120
7N/35W-26J6	05-31-83	1910	184	2,050	7.2	17.5	980	580	210	110
7N/35W-26K1	05-31-83	1925	--	2,140	7.5	17.5	850	430	180	97
7N/35W-27H2	06-02-83	1440	--	2,000	7.2	18.0	830	560	220	68
7N/35W-33J2	07-14-83	1000	465	1,090	7.1	19.0	360	180	97	29
7N/35W-33J4	04-14-83	1040	--	1,120	7.5	18.5	420	230	110	35
7N/35W-36A2	06-01-83	0840	176	1,450	7.1	17.0	650	270	140	73
7N/35W-36J6	05-31-83	1830	--	2,430	7.2	16.0	1,100	670	190	140
7N/35W-36J8	05-31-83	1840	--	2,480	7.2	16.5	1,100	690	200	150

¹Water-quality analyses furnished by the city of Lompoc.

Sodium, dis- solved (mg/L as Na)	Percent sodium	Sodium ad- sor- p- tion ratio	Potas- sium, dis- solved (mg/L as K)	Alka- linity, field (mg/L as CaCO ₃)	Alka- linity, lab (mg/L as CaCO ₃)	Sul- fate, dis- solved (mg/L as SO ₄)	Chlo- ride, dis- solved (mg/L as Cl)	Fluo- ride, dis- solved (mg/L as F)	Silica, dis- solved (mg/L as SiO ₂)	Solids, residue at 180 °C dis- solved (mg/L)
--	--	--	--	340	--	--	220	--	--	--
91	22	1.6	2.7	380	394	310	140	0.4	45	--
87	20	1.5	3.4	410	411	350	140	.3	40	--
180	26	2.4	9.5	430	478	160	600	.1	40	--
180	60	5	1.4	--	223	190	160	<.1	39	--
130	45	3.4	6.5	210	238	130	190	.2	42	--
120	39	3	4.3	--	237	86	240	.1	34	--
95	40	2.4	3.1	--	223	71	150	<.1	44	--
180	60	5	1.4	--	225	200	160	<.1	38	--
120	40	2.8	6.2	250	271	110	220	.2	40	--
120	41	3	4.8	240	253	98	210	.2	44	--
200	34	3.0	9.6	380	382	460	270	.1	44	--
92	28	2	3.9	280	282	240	140	.1	46	--
160	38	3.0	7.5	310	322	230	260	.2	47	--
95	29	2.0	3.9	--	188	170	250	<.1	41	--
83	34	2.1	3.6	190	179	100	180	<.1	42	--
140	32	2.6	5.5	250	270	280	270	<.1	41	--
--	--	--	--	363	--	--	200	--	--	--
90	22	1.6	4.3	320	316	440	100	.3	39	--
115	--	--	7.5	--	397	652	141	.4	42	1,856
110	--	--	6.2	--	392	462	110	.5	40	1,482
78	--	--	5.2	--	310	365	87	.5	41	1,126
170	26	2.3	5.4	390	379	760	180	.3	39	--
150	20	1.8	5.9	470	487	830	220	.2	36	--
120	21	1.7	4.2	490	486	430	180	.5	41	--
--	--	--	--	442	--	--	250	--	--	--
81	--	--	7.4	--	275	368	101	.5	42	1,123
87	--	--	6.8	--	301	377	89	.5	43	1,172
114	--	--	5.2	--	412	515	130	.4	43	1,592
170	32	2.6	7.6	390	386	420	250	.4	39	--
140	26	2.1	5.2	360	363	490	190	.4	36	--
160	65	5.0	6.4	39	45	120	220	.2	44	--
760	65	11	25	--	537	260	1,200	.3	36	--
640	53	8.0	28	--	334	370	1,400	.2	37	--
2,400	70	23	68	--	504	1,100	4,100	.5	33	--
210	30	2.8	10	470	570	500	380	.1	39	--
--	--	--	--	485	--	--	520	--	--	--
300	33	3.6	11	500	488	910	510	.2	40	--
190	27	2.5	10	440	434	570	370	.1	40	--
220	68	6.7	2.4	180	235	240	170	.7	24	--
180	25	2.3	8.4	440	433	650	300	.2	41	--
190	28	2.6	8.6	--	426	600	290	.2	43	--
200	28	2.6	9.8	490	468	640	310	.2	39	--
160	23	2.1	6.7	--	426	720	300	.1	42	--
150	22	2.0	5.7	--	431	650	220	.2	40	--
120	21	1.7	4.6	400	430	500	220	.2	39	--
140	26	2.1	5.4	420	379	460	220	.4	38	--
120	24	1.8	4.8	270	264	300	340	<.1	38	--
81	32	2.4	3.7	180	187	120	180	.2	36	--
75	28	1.7	4.6	190	201	120	200	.2	44	--
79	21	1.5	2.5	380	382	270	130	.2	39	--
160	25	2.1	2.4	380	442	650	230	.2	42	--
160	24	2.1	1.8	430	442	630	240	.2	43	--

11.0 DATA-CHEMICAL ANALYSES OF GROUND WATER FROM THE MAIN WATER-BEARING ZONE--Continued

Well No.	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO ₂ +NO ₃ , dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as NH ₄)	Nitrogen, organic, dissolved (mg/L as N)	Nitrogen ammonia + organic, dissolved (mg/L as N)	Nitrogen, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Boron, dissolved (ug/L as B)	Iron, dissolved (ug/L as Fe)
6N/34W-5H5	--	--	--	--	--	--	--	--	--	--
6N/34W-9A4	1,100	2.4	<0.06	0.08	--	0.3	2.7	0.16	190	93
6N/34W-9A5	1,100	<.10	.11	.14	0.19	.3	--	<.01	150	1,300
7N/34W-19C1	1,160	--	--	--	--	--	--	--	220	50
7N/34W-19C2	790	--	--	--	--	--	--	--	420	58
7N/34W-19E1	740	--	--	--	--	--	--	--	210	<3
7N/34W-19E2	760	--	--	--	--	--	--	--	150	29
7N/34W-19F1	600	<.10	--	--	--	--	--	--	120	530
7N/34W-19F2	800	--	--	--	--	--	--	--	420	33
7N/34W-19J1	790	.23	--	--	--	--	--	--	210	590
7N/34W-19J6	760	<.10	--	--	--	--	--	--	160	420
7N/34W-19N2	1,500	.15	3.2	4.1	0	3.1	3.3	.06	610	30
7N/34W-20K6	880	<.10	--	--	--	--	--	--	260	170
7N/34W-20M2	1,100	<.10	--	--	--	--	--	--	480	530
7N/34W-22J6	859	2.2	<.06	.08	--	.4	2.6	.09	160	100
7N/34W-23L2	640	3.4	.06	.08	--	.5	3.9	.08	200	10
7N/34W-25F3	1,140	5.9	.16	.21	.44	.6	6.5	.14	390	45
7N/34W-26F6	--	--	--	--	--	--	--	--	--	--
7N/34W-27G4	1,100	<.10	.66	.85	.14	.8	--	.02	500	300
7N/34W-27N51	--	--	--	--	--	--	--	--	560	--
7N/34W-27P51	--	--	--	--	--	--	--	--	460	--
7N/34W-27Q21	--	--	--	--	--	--	--	--	460	--
7N/34W-29J1	1,700	<.10	.51	.66	.19	.7	--	.01	820	40
7N/34W-30L5	1,900	<.10	3.9	5.0	1.9	5.8	--	.01	730	50
7N/34W-31Q4	1,400	7.6	<.06	.08	--	.4	8.0	.32	250	50
7N/34W-32P1	--	--	--	--	--	--	--	--	--	--
7N/34W-34A41	--	--	--	--	--	--	--	--	440	--
7N/34W-34B11	--	--	--	--	--	--	--	--	440	--
7N/34W-34F61	--	--	--	--	--	--	--	--	520	--
7N/34W-35C4	1,400	<.10	.79	1.0	.21	1.0	--	.16	740	50
7N/34W-35C6	1,400	.13	.17	.22	.23	.4	.53	.19	810	50
7N/35W-13N2	630	15	<.06	--	--	1.6	17	.74	250	67
7N/35W-17G1	2,900	.28	--	--	--	--	--	--	1,400	80
7N/35W-17K20	3,000	.22	--	--	--	--	--	--	440	250
7N/35W-17Q6	8,600	<.10	--	--	--	--	--	--	1,800	2,400
7N/35W-21G2	1,800	.10	--	--	--	--	--	--	320	30
7N/35W-22J2	--	--	--	--	--	--	--	--	--	--
7N/35W-22J3	2,500	<.10	2.6	3.3	.60	3.2	--	.02	860	1,300
7N/35W-22R1	1,800	<.10	2.9	3.7	0	2.8	--	<.01	330	70
7N/35W-23B2	840	<.10	--	--	--	--	--	--	330	1,300
7N/35W-23K1	1,800	<.10	1.9	2.4	.50	2.4	--	.01	740	870
7N/35W-24P3	1,700	<.10	2.4	3.1	.60	3.0	--	.02	870	310
7N/35W-25D3	1,900	<.10	1.9	2.4	.60	2.5	--	.01	870	90
7N/35W-26F4	1,900	<.10	--	--	--	--	--	--	350	2,600
7N/35W-26H1	1,700	<.10	.46	.59	.14	.6	--	.02	650	610
7N/35W-26J6	1,400	<.10	.61	.79	.19	.8	--	.01	300	30
7N/35W-26K1	1,370	.10	.52	.67	.58	1.1	--	.18	690	60
7N/35W-27H2	1,300	.25	.33	.43	.57	.9	1.2	.61	150	20
7N/35W-33J2	660	.97	--	--	--	--	--	--	70	11
7N/35W-33J4	700	.88	--	--	--	--	--	--	70	23
7N/35W-36A2	960	.13	.10	.13	.30	.4	.53	.16	210	22
7N/35W-36J6	1,600	4.0	.29	.37	1.1	1.4	5.4	.28	370	10
7N/35W-36J8	1,700	4.6	3.2	4.1	.80	4.0	8.6	.27	340	20

¹Water-quality analyses furnished by the city of Lompoc.