WATER-RESOURCES APPRAISAL OF THE UPPER ARKANSAS RIVER BASIN FROM LEADVILLE TO PUEBLO, COLORADO

By Thomas M. Crouch, Doug Cain, P. O. Abbott, Robert D. Penley, and R. Theodore Hurr

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U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 82-4114

Prepared in cooperation with the

SOUTHEASTERN COLORADO WATER CONSERVANCY DISTRICT;

COLORADO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER RESOURCES, OFFICE OF THE STATE ENGINEER;

UPPER ARKANSAS WATER CONSERVANCY DISTRICT; and

CHAFFEE AND FREMONT COUNTIES

Lakewood, Colorado
1984

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

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METRIC CONVERSION FACTORS

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

Multiply	*By*	*To obtain*
acre	0.4047	hectare
acre-foot (acre-ft)	1.233×10^{-3}	cubic hectometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
gallon per minute (gal/min)	0.6309	liter per second
inch (in.)	25.40	millimeter
mile (mi)	1.6093	kilometer
square mile (mi^2)	2.590	square kilometer
cubic foot per second per square mile	0.01093	cubic meter per second per square kilometer

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

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ABSTRACT

The upper Arkansas River basin from Leadville to Pueblo, Colo., is a high altitude, intermountain, agricultural and ranching community that consists of several structurally formed, alluvial-filled subbasins joined by the Arkansas River. The purpose of the study was to provide a reconnaissance investigation of the quantity, quality, and availability of ground- and surface-water resources of the area.

Most water supplies in the basin are presently (1982) diverted by canals from surface-water sources. During droughts, the exercise of senior water rights in the lower Arkansas River in Colorado can substantially reduce upstream diversions. The recently completed Fryingpan-Arkansas River project has changed the flow regime of the Arkansas River by increasing reservoir storage and by importing 69,200 acre-feet per year of water from the Colorado River drainage.

The volume of hydrologically recoverable ground water in the upper 200 feet of unconsolidated saturated materials in the Leadville and Buena Vista-Salida basins and the Wet Mountain Valley is estimated to be 10.2 million acre-feet. Ground water also is available in the Dakota-Purgatoire aquifer, with well yields reportedly as much as 300 gallons per minute. Gain-loss studies indicate hydraulic connection between the Arkansas River and the ground-water system with ground water contributing to streamflow in the study area.

The quality of ground and surface water is acceptable for most uses with hardness, iron, manganese, pH, and sulfate exceeding recommended drinking-water criteria during low flow in the river. Dissolved solids increase downstream because of increased water use and decreased precipitation and ground-water inflow. Acid mine drainage has seriously degraded water supplies in the Leadville area. Water in the Dakota-Purgatoire aquifer has concentrations of radiochemical constituents that exceeded drinking-water criteria.

INTRODUCTION

The upper Arkansas River basin is an agricultural and ranching community that relies extensively on water locally available in the Arkansas River and its tributaries. At present (1982), ground water is used mostly for domestic purposes, stock watering, and some municipal supplies.

The upper Arkansas River basin is the headwaters of the Arkansas River and the source area for a large percentage of the surface water used in southeastern Colorado. Colorado water law stipulates that the volume and frequency of diversions from the river be administered according to the prior-appropriation doctrine by the Colorado Division of Water Resources, Office of the State Engineer. That doctrine establishes a priority system based on "first in-use, first in-right." During extended low flows or drought, senior water rights in the lower Arkansas River basin in Colorado can stop or substantially reduce upstream diversions.

The objectives of this study were to determine on a reconnaissance level (1) the quantity, quality, and availability of both surface and ground water; and if possible (2) the potential for development of the ground-water system.

The scope of this investigation included a review of data and reports previously written about the basin, an evaluation of streamflow and reservoirs, a determination of the quality of available water, the expected yields from properly constructed wells completed in various aquifers, the volume of water available in ground-water storage, and a definition of the potentiometric surface in the confined and unconfined aquifers. Gain-loss evaluations were made on several main-stem reaches of the Arkansas River and its tributaries to determine surface- and ground-water relationships.

Location and General Features of Study Area

The upper Arkansas River basin (fig. 1) is a high-altitude, semiarid basin that extends from Leadville to Pueblo, Colo., a straight-line distance of approximately 120 mi. The total study area is about 5,200 mi^2 and includes all of Lake, Chaffee, Fremont, and Custer Counties; and parts of Saguache, Park, Teller, El Paso, and Pueblo Counties. National forests cover about one-third of the area. Altitudes in the basin range from about 4,670 ft at Pueblo to 14,433 ft at Mount Elbert in Lake County--the highest peak in Colorado.

Most of the population and related activities are located along the broad, gently sloping terrain of the Arkansas River. The principal towns in the study area are Pueblo, Canon City, Salida, Buena Vista, Leadville, and Westcliffe. According to the 1970 census (U.S. Bureau of Census, 1971), the population of the upper Arkansas River basin, excluding the city of Pueblo, was 48,200. This represents an increase of about 2,000 people since 1960.

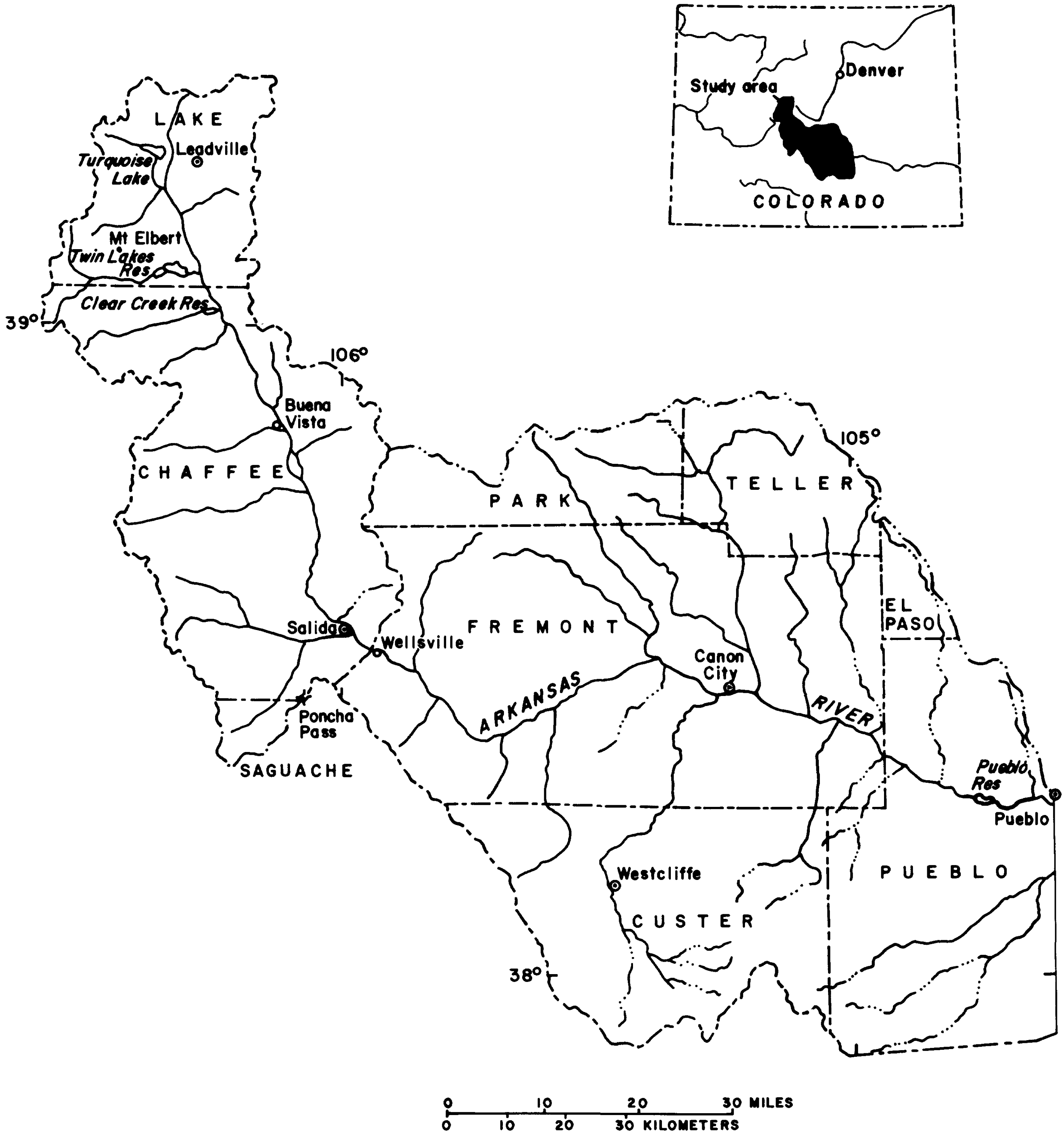

Figure 1.--Location of study area.

Preliminary data from the 1980 census (U.S. Bureau of Census, 1981) indicates approximately 54,000 people reside in the study area. The principal industry in the area is currently (1982) ranching. Historically, mining of precious metals dominated the economy of the area. The mines produced large quantities of gold, silver, and lead, but most of them are now abandoned. Molybdenum continues to be mined at a large operation near Leadville.

Acknowledgments

This study was made by the U.S. Geological Survey in cooperation with the Southeastern Colorado Water Conservancy District; Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer; Upper Arkansas Water Conservancy District; and Chaffee and Fremont Counties. The authors thank the many ranchers, drillers, well owners, and officials of the cities and counties in the study area for their cooperation and willingness to make available the data necessary for this report.

HYDROLOGIC SETTING

Rocks in the upper Arkansas River basin range in age from Quaternary to Precambrian (pl. 1). Relatively thin alluvial deposits of sand, gravel, and silt of Quaternary age, which readily supply water to wells, occur along the Arkansas River except in the reach between Salida and Canon City where the river generally flows across crystalline bedrock or consolidated sedimentary deposits. Three structural basins--the Leadville basin, the Buena Vista-Salida basin, and the Wet Mountain Valley--contain thick deposits of saturated alluvial material of Quaternary and Tertiary age. East of Canon City a sloping plain, known as the Canon City embayment--consisting of several aquifers, has been eroded on eastward-dipping and gently folded sedimentary rocks mostly of Cretaceous age.

The mountain ranges are composed of sedimentary, igneous, and metamorphic rocks. The sedimentary rocks are of Paleozoic age while the igneous and metamorphic rocks principally are of Precambrian age. Volcanic rocks, mostly of Tertiary age, flank the mountain ranges in some areas.

Major tributaries to the Leadville and Buena Vista-Salida basins include East Fork and Tennessee Fork (not shown, pl. 1) at the north end of the Leadville basin; Lake Fork, Halfmoon Creek, Lake Creek, Clear Creek, Cottonwood Creek, Chalk Creek, and the South Arkansas River discharge from the Sawatch Range and contribute to the flow of the Arkansas River in the Buena Vista-Salida basin. The natural discharge of the river is supplemented by transmountain diversions through several ditches and tunnels. Downstream from Salida, Badger Creek, Currant Creek, Fourmile Creek, and Eightmile Creek drain the mountains on the north side of the Arkansas River. Texas Creek and Grape Creek drain the Wet Mountain Valley to the south of the river. Hardscrabble Creek drains the northern part of the Wet Mountains southeast of Cañon City. The Arkansas River flows into Pueblo Reservoir at the downstream end of the study area.

Precipitation and transmountain diversions are the principal sources of water in the upper Arkansas River basin. Based on climatological data from the U.S. Weather Bureau (1967), the average annual precipitation in the study area varies from less than 10 in. to more than 40 in. (pl. 2), generally increasing with altitude. The greater volumes of precipitation occur mostly as snowfall at altitudes above 11,000 ft.

GROUND WATER

Occurrence

In the upper Arkansas River basin there are many different aquifers with a variety of hydrologic characteristics. The stratigraphic sequence of the geologic units, plus a summary of their physical and hydrologic characteristics are presented in table 1. In addition, aquifers known to yield water to wells are discussed, from youngest to oldest, in the following text. A generalized areal distribution of the principal geohydrologic units is shown on plate 1. The location of wells and springs for which hydrologic data are available are shown on plate 3 with the data presented in the Supplemental Information section.

Unconsolidated Rock Aquifers

The most productive aquifers in the basin are the unconsolidated rock aquifers consisting of alluvial, glacial, and basin-fill deposits. Alluvial deposits of Quaternary age occur along the Arkansas River and its major tributaries except in the reach between Salida and Canon City. Glacial deposits of Quaternary age and thick, extensive basin-fill deposits of Tertiary age occur in the Leadville and Buena Vista-Salida ground-water basins and in the Wet Mountain Valley (fig. 2). The basin-fill deposits in the Leadville and Buena Vista-Salida basins are called the Dry Union Formation. In the Wet Mountain Valley they are called the Santa Fe Formation. These formations are virtually equivalent in age and lithology.

The water-yielding potential of these aquifers varies greatly but generally increases with saturated thickness, improved sorting, and a decrease in clay and silt content. Confined (artesian) conditions may occur in the unconsolidated rock aquifers. Water in sand and gravel units is more likely to be confined in the center of the basins where clay or silt beds are thicker and more areally continuous. Water will flow from wells penetrating the confined aquifers in areas where the potentiometric surface is above land surface.

Table 1.--*Generalized stratigraphic relationships, and physical and hydrologic characteristics of geologic units*

System	Series	Group formation and member	Thickness, in feet[1]	Physical description	Hydrologic characteristics	Water-supply potential
Quaternary	Holocene	Valley-fill alluvium	0-100	Unconsolidated clay, silt, sand, gravel, and cobbles deposited by streams and rivers.	Water occurs in interstices under unconfined and locally confined (artesian) conditions.	Variable, depending on saturated thickness, texture, and sorting; generally 50 to 500 gal/min but up to 1,000 gal/min.
	Pleistocene	Glacial deposits	0-500	Moraine and outwash deposits of poorly sorted send, gravel, cobbles, and boulders containing layers of silt and clay.	Water occurs in interstices under unconfined and locally confined (artesian) conditions.	Variable, depending on saturated thickness, texture, and sorting; well yields range from less than 10 gal/min to as much as 1,500 gal/min.
Tertiary	Pliocene / Miocene	Santa Fe Formation and Dry Union Formation (basin-fill aquifers)	0-6,700	Unconsolidated to poorly consolidated sand, gravel, and cobbles, with interbedded coherent siltstone beds and friable sandstones and volcanic ash beds.	Water occurs in interstices under unconfined and confined (artesian) conditions. Secondary porosity may result from fracturing of coherent siltstones and sandstones.	Variable, depending on saturated thickness, texture, and sorting; presence of fractures may increase potential locally. Well yields range from about 10 to as much as 1,200 gal/min, but most penetrate only a small fraction of the aquifer; potential yield known for most areas.
	Oligocene	Volcanic rocks	0-1,500	Primarily andesitic and basaltic flows, flow breccias, lahars, and rhyolite flows and ash-flow tuffs. Includes local interflow sands and gravels.	Water occurs in the interstices of tuffaceous deposits and interflow sands and gravels, and in fractures of the flow.	Yields to wells are generally less than 10 gal/min, but as much as 30 gal/min in the Wet Mountain Valley.
	Eocene	Intrusive igneous rocks	-------	Granodiorite, quartz monzonite, and granite stocks, dikes, and sills.	Water occurs only in fractures.	No known wells in these rocks. Expected yield in properly located wells is 1 to 5 gal/min.
	Paleocene	Poison Canyon Formation	530-550	Medium-grained massive sandstone; conglomerate in lower part. Partly volcaniclastic.	Water occurs in the interstices, probably under unconfined conditions only.	May yield small quantities of water to wells. Formation may be drained throughout most of the area.
		Intrusive igneous rocks	-------	Quartz monzonite, grandiorite, and quartz diorite porphyries.	Water occurs only in fractures.	No known wells in these rocks.
Cretaceous	Upper Cretaceous	Raton Formation	150-500	Interbedded sandstone, siltstone, shale, and coal.	Water occurs in interstices, usually unconfined, but may be confined.	May yield small quantities of water to wells. Formation may be drained throughout most of the area.
		Vermejo Formation	300-340	Sandstone and interbedded carbonaceous, silty shale, and coal.	Water occurs in interstices, usually unconfined but may be confined.	May yield small quantities of water to wells.
		Trinidad Sandstone	50-60	Medium- to fine-grained massive sandstone.	Water occurs in interstices, usually unconfined but may be confined.	Reported well yields range from 20 to 100 gal/min.
		Pierre Shale	2,000-3,900	Siltstone, claystone, and shale, with sandstone near top and bottom.	Water occurs in the interstices of sandstone or in fractures in the siltstone and claystone.	May yield small quantities of water to wells.
		Niobrara Formation	600-700	Gypsiferous shale underlain by the Fort Hays Limestone Member; approximately 40 feet of chalky limestone beds separated by thin shale partings.	Water occurs in fractures and and possibly in solution openings of the Fort Hays Limestone Member.	Reported well yields of the Fort Hays Limestone Member range from 2 to 110 gal/min.
		Carlile Shale	200-230	Contains an upper sandstone member and two underlying shales.	Water may occur locally in fractures or in interstices of the sandstone member.	No known wells in this formation. Generally is not an aquifer.
		Greenhorn Limestone: Bridge Creek Limestone Member	30-55	Thin-bedded limestone with interbedded shale.	Water may occur where the unit is fractured.	Reported well yields up to 40 gal/min.
		Greenhorn Limestone: Hartland Shale Member and Lincoln Limestone Member	90-100	Soft shale containing layers and lenses of clastic limestone.	Water may occur where the units are fractured.	No known wells in these members. Generally not aquifers.

Table 1.--*Generalized stratigraphic relationships, and physical and hydrologic characteristics of geologic units*--Continued

System	Series	Group formation and member	Thickness, in feet[1]	Physical description	Hydrologic characteristics	Water-supply potential
Cretaceous	Upper Cretaceous	Graneros Shale	90–130	Soft to moderately hard fissile clayey shale and siltstone.	Water may occur where the unit is fractured.	No known wells in this formation. Generally is not an aquifer but a confining bed for the underlying Dakota-Purgatoire aquifer.
	Lower Cretaceous	Dakota Sandstone	90–130	Fine- to medium-grained massive sandstone with interbedded shale.	Water occurs in interstices snd fractures in the sandstones and in fractures in the shale. Unit is unconfined in outcrop areas but under confined (artesian) conditions where overlain by consolidated rocks. Wells flow in areas where artesian pressure head is above land surface.	The Dakota-Purgatoire aquifer provides greatest yields to wells where it is extensively fractured. Reported well yields range from 3 to 1,600 gal/min, but are generally from 10 to 500 gal/min. Unit may be drained in outcrop aress. In some areas, water has been reported to be warm and mineralized.
		Purgatoire Formation: Glencairn Shale Member (=Kiowa Shale)	90–100	Predominately shale with thin beds of sandstone and siltstone.		
		Purgatoire Formation: Lytle Sandstone Member (=Cheyenne Sandstone)	100–150	Massive fine- to medium-grained sandstone with thin beds and lenses of siltstone and conglomerate.		
Jurassic	Middle and Upper Jurassic	Morrison Formation and Ralston Creek Formation	260–350	Mudstone containing numerous lenses of fresh-water limestone and beds of sandstone, and arkosic sandstone and limestone.	Water occurs in interstices of sandstone and in fractures in mudstone and limestone.	Reported well yields range from 12 to 60 gal/min.
		Entrada Sandstone	50–100	Fine- to coarse-grained arkosic sandstone.	Water occurs in the interstices and locally in fractures.	Reported to yield water to wells; no data available.
Pennsylvanian and Permian		Fountain Formation	1,500–4,500	Coarse-grained arkosic conglomerate and sandstone with interbedded siltstone and shale.	Water occurs in interstices and fractures; unconfined in outcrop areas and confined in the subsurface.	Well yields are generally 5 to 25 gal/min, but yields up to 100 gal/min have been reported.
Mississipian		Leadville Limestone	0–200	Oolitic limestone.	Water may occur in fractures and solution openings.	No known wells in this unit. Probably is an aquifer with potential for development.
Devonian		Williams Canyon Limestone	0–200	Finely crystalline dolomitic limestone.	Water may occur in fractures and solution openings.	No known wells in this unit. May be an aquifer with potential for development.
Ordovician		Fremont Dolomite	0–20	Hard dolomitic limestone with chert bands.	Water may occur in fractures and solution openings, and also in intergranular openings produced by volume reduction from dolomitization.	No known wells in this unit. May be an aquifer with potential for development.
		Harding Sandstone	0–75	Fine-grained, thin-bedded sandstone.	Water occurs in the interstices and possibly in fractures.	Well yields are reportedly less than 50 gal/min.
		Manitou Limestone	0–40	Interbedded limestone and dolomite, locally sandy, cherty, and oolitic.	Water may occur in fractures and solution openings.	No known wells in this unit. May be an aquifer and may have potential for development.
Crystalline rocks of the Precambrian		Igneous rocks	-------	Primarily medium- to coarse-grained acidic intrusives; granite, diorite, and granodiorite. May be foliated or porphyritic.	Water occurs only in fractures.	Yields to wells are generally less than 10 gal/min. Higher yields may be obtained with careful exploration for areas of major fracture systems.
		Metamorphic rocks	-------	Primarily biotite-quartz-plagioclase gneiss. Migmatitic.		

[1]Thickness is approximate where no range in values is given.

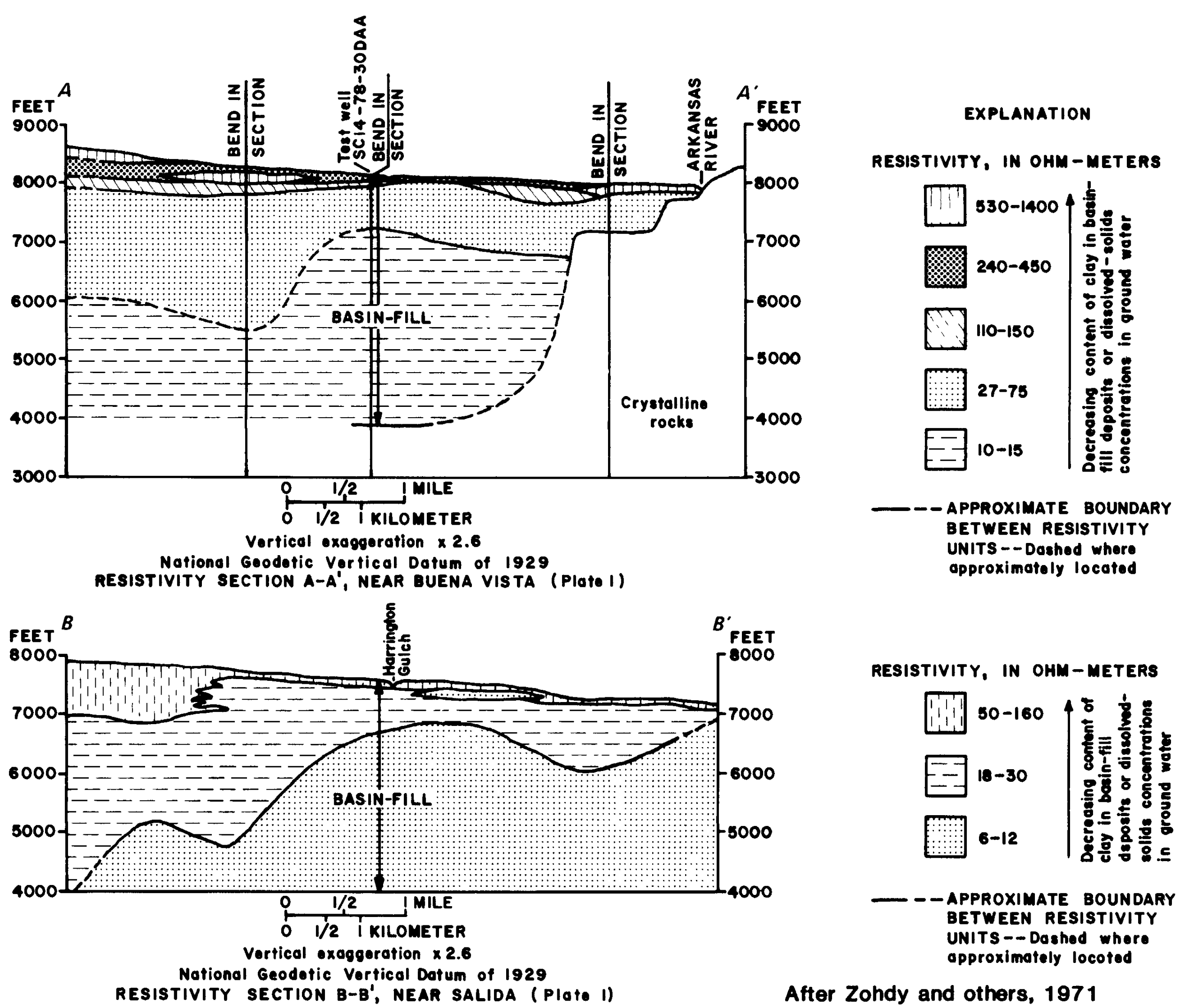

Figure 2.--Resistivity sections, Buena Vista-Salida ground-water basin, upper Arkansas River basin from Leadville to Pueblo, Colorado.

Alluvial deposits along the major rivers and streams are composed primarily of sand, gravel, and cobbles with dispersed clay and silt lenses. The deposits were derived from erosion and stream transport of rocks from the adjacent mountains and from stream reworking of previously deposited glacial and basin-fill deposits. Where valley-fill aquifers overlie glacial or unconsolidated basin-fill aquifers, there may be no clear differentiation in lithologic or hydrologic characteristics and wells may obtain water from both aquifers. The valley-fill aquifers generally range in thickness from 0 to 100 ft; a few wells are reported to penetrate the valley-fill aquifers and obtain water from the underlying glacial or basin-fill deposits. Between Canon City and Pueblo the thickness of saturated alluvium along the Arkansas River ranges from 0 to 50 ft. Data from well records indicate the water table is less than 10 ft below land surface in about one-half of the wells completed in the valley-fill aquifer and less than 20 ft below land surface in three-fourths of the wells. Areas of shallower depths to water generally are found nearer the streams and in topographically low areas.

Glacial deposits overlie the basin-fill deposits in most areas of the Leadville and Buena Vista-Salida basins and the Wet Mountain Valley (pl. 1). The glacial deposits vary widely in composition, from clay beds to cobble and boulder deposits, depending on the mechanism of deposition. Till deposits, such as moraines, tend to be unstratified, poorly sorted, and include considerable dispersed silt and silt lenses. The till deposits generally yield small quantities of water to wells. Outwash deposits are partly stratified and sorted and may provide large quantities of water to wells.

Basin-fill deposits occur in the three down-faulted intermontane basins in the upper Arkansas River basin: the Leadville and the Buena Vista-Salida basins, and the Wet Mountain Valley. These deposits are composed of friable to unconsolidated sand and gravel and interbedded loosely coherent sandy siltstone. The basin-fill deposits were formed by movement of sediments from the surrounding mountains and accumulated through late Tertiary time as the basin floors subsided under the increasing weight of sediments and interstitial water. Streams emanating from the mountains deposited the bulk of these materials, aided by landslides, wind, and volcanic eruptions. The deposits generally are composed of finer-grained materials near the center of the basins.

Leadville Basin

The Leadville ground-water basin (pl. 1) is an elongated series of down-faulted blocks in the headwaters of the Arkansas River drainage. The basin is bounded on the north by the Sawatch Range and on the east by the Mosquito Range. Basin-fill deposits of Tertiary age and glacial-outwash deposits of Quaternary age occupy about 100 mi^2 of the Leadville ground-water basin. The glacial deposits cover the basin-fill deposits in about three-fourths of the basin; thicknesses are as much as 400 ft, but probably average about 100 ft. Minor quantities of alluvium have been deposited along the Arkansas River and in tributary valleys.

Geophysical investigations (Tweto and Case, 1972) indicate the glacial and basin-fill deposits may be 3,000 to 4,000 ft thick in the south-central part of the Leadville ground-water basin. Ogden Tweto (U.S. Geological Survey, written commun., 1964) analyzed cuttings from two wells located in sec. 27, T. 9 S., R. 80 W., and determined the glacial deposits to be 80 to 90 ft thick and the underlying Dry Union Formation of Tertiary age to be 500 to 600 ft thick. One of these wells, SC00908027DBC, was reported to yield 180 gal/min. The top of the Dry Union Formation generally lies within 100 ft of the land surface. Water levels in the glacial deposits range from 1 to more than 100 ft but generally are 2 to 40 ft below land surface. Water levels in the Dry Union Formation generally range from 20 to 200 ft below land surface, being deeper near the mountains and shallower near the Arkansas River and the downstream reaches of its major tributaries.

Buena Vista-Salida Basin

The Buena Vista-Salida ground-water basin occupies a downfaulted trough in the Precambrian basement rock. The basin, which extends from several miles north of Buena Vista southward to Poncha Pass and southwest to Salida (pl. 1), is flanked on the west by the Sawatch Range and on the east by the Mosquito Range. Deposits of coarse alluvium occur adjacent to the Arkansas River along the east margin of the basin. Nine sequences of multiple-stage glacial-outwash deposits, consisting mainly of tightly packed rounded cobbles and boulders, have been described by Van Alstine (1969). In about 200 mi^2 of the basin, fine-grained deposits of the Dry Union Formation underlie the glacial-outwash deposits. The Dry Union Formation consists of as much as 4,000 ft of clay, silt, sand, and gravel. The sediments locally contain volcanic-glass, bentonite, and rhyolitic-tuff layers (Van Alstine, 1969).

The thickness and hydrologic properties of the alluvial and basin-fill deposits of the Buena Vista-Salida ground-water basin were determined from surface geophysical resistivity surveys made at two locations shown on plate 1 (Zohdy and others, 1971). Data from Resistivity section A-A' in figure 2 indicates the thickness of the basin-fill deposits south of Buena Vista to be as much as 4,600 ft. A test well (SC01407830DAA) was drilled to a depth of 1,000 ft along the line of the resistivity section to verify the electrical-resistivity interpretations. A log of the rock types penetrated by this well is presented in the Supplemental Information section and corresponds to a description of the Dry Union Formation by Van Alstine (1969). The water level was 26 ft below land surface when the well was completed. Data obtained from resistivity section B-B' (fig. 2) near Salida indicate the thickness of the alluvial and basin-fill deposits exceeds 4,000 ft.

Water for domestic and stock use in the Buena Vista-Salida ground-water basin is obtained from wells in the alluvial deposits at depths generally less than 100 ft. In the southern one-half of the basin, the Dry Union Formation yields water to wells that are generally 100 to 200 ft deep.

Along the western margin of the Buena Vista-Salida ground-water basin there are springs that discharge warm to hot mineralized water. Many of thse springs have been developed for commercial purposes by resort hotels. There is also interest in the development of geothermal resources in this area.

The source of water issuing from these springs and the source of the heat warming the water probably is the intrusive igneous rocks of Tertiary age that borders the basin. Another possible source of warm water is the deeper part of the basin-fill aquifer. In the thick basin-fill deposits of the upper Arkansas River basin, water with temperatures of 30 to 40°C might be developed from depths of 2,000 to 3,000 ft.

A temperature profile was obtained for test well SC01407830DAA near Buena Vista. The temperature profile is shown in figure 3 and a list of temperatures at selected depths is given in table 2. A temperature gradient of 1.1° and 1.4°C per 100 ft was measured to a depth of about 600 ft. These gradients are similar to the average temperature gradient of 1.2°C per 100 ft for the confined aquifer of the San Luis Valley (Emery and others, 1973), but is relatively large compared to typical gradients of 0.5° to 0.7° per 100 ft observed by Keys and MacCary (1971) in similar materials.

Table 2.--*Temperature log of well SC01407830DAA*

Depth, in feet,	Water temperature, in degrees Celsius	Depth, in feet	Water temperature, in degrees Celsius
30	9.55	675	16.44
50	9.55	700	16.55
100	10.10	725	16.64
150	10.40	750	16.72
200	10.72	760	16.75
250	11.33	770	16.79
300	11.85	780	16.82
354	12.43	790	16.86
400	13.07	800	16.95
450	13.74	810	17.07
500	14.44	820	17.21
550	15.00	830	17.52
565	15.05	840	17.83
580	15.36	860	18.14
600	15.80	880	18.40
610	15.96	900	18.61
620	16.06	920	18.82
630	16.15	940	19.05
640	16.26	960	19.27
650	16.35	974	19.40

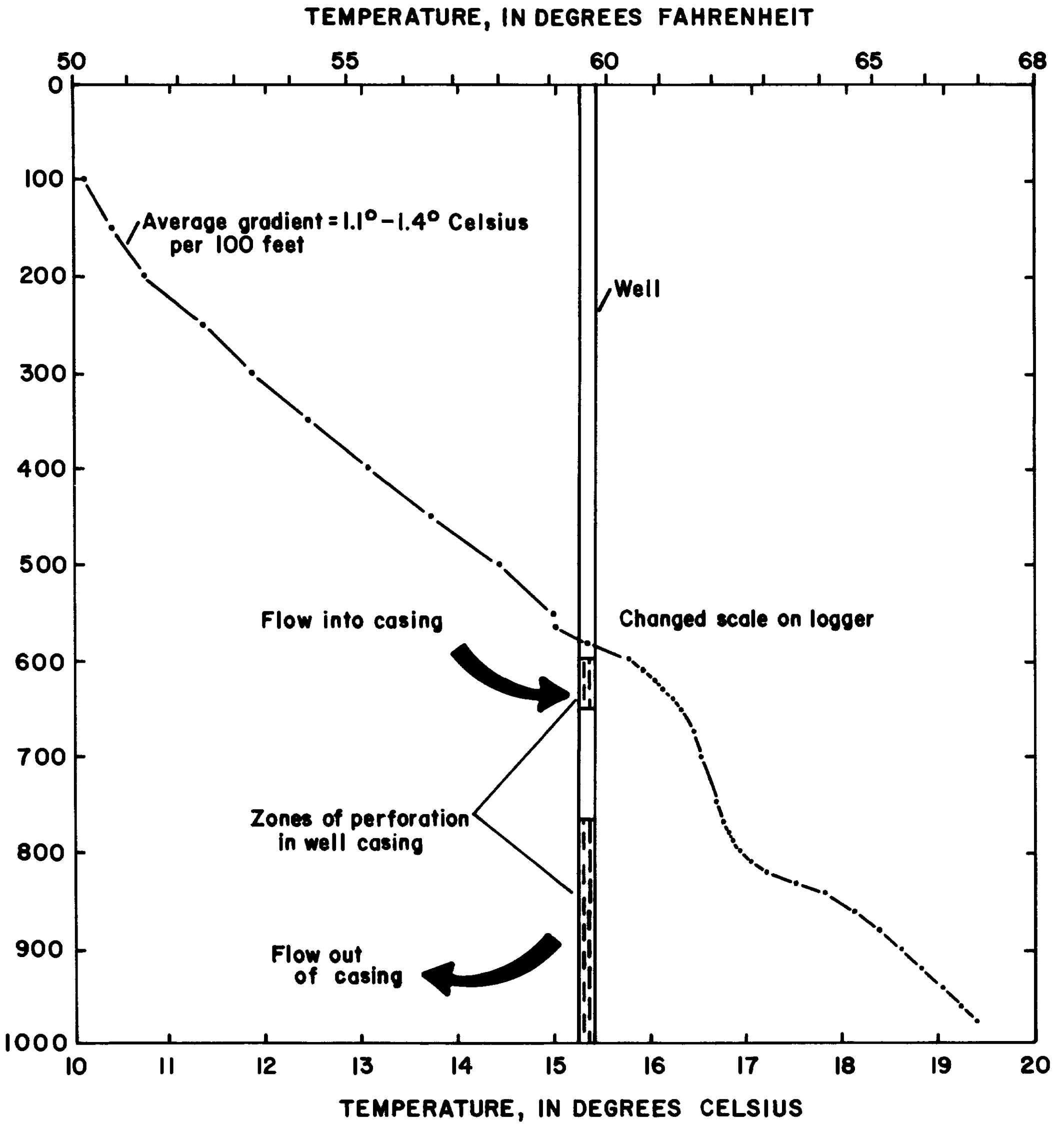

Figure 3.--Relation between water temperature and depth in well SC01407830DAA.

The temperature profile shown in figure 3 also indicates there is vertical movement of fluid in or adjacent to the well bore. The figure shows there are changes in the temperature gradient in the well bore between depths of about 600 and 800 ft. From 600 to 650 ft, the temperature gradient begins to decrease and is about 0.4°C per 100 ft from 650 to 800 ft. The gradient decrease probably results from downward movement of cool water that enters the well casing in the upper perforated interval (599 to 641 ft). At approximately 800 ft the gradient again changes, probably due to water flowing out of the casing through the lower perforated interval (767 to 1,000 ft). At approximately 850 ft the gradient was once again about 1.0°C per 100 ft. The downward movement indicates either a deep circulatory flow pattern for a single continuous aquifer, or two or more aquifers separated by a confining or partly confining layer. The driller's log indicated a single continuous aquifer.

Wet Mountain Valley

The Wet Mountain Valley (pl. 1), located approximately 60 mi southwest of Pueblo, is an intermontane, downfaulted trough flanked on the west by the Sangre de Cristo Range and on the east by the Wet Mountains. The valley contains basin-fill deposits of Tertiary age and glacial and alluvial deposits of Quaternary age. The basin-fill deposits are represented by the Santa Fe Formation, which is correlative with the Dry Union Formation in the Leadville and Buena Vista-Salida ground-water basins. The Santa Fe Formation, derived from erosion of the surrounding mountains, consists of as much as 6,700 ft of clay, silt, fine gravel, and sand that is exposed in about 230 mi^2 of the Wet Mountain Valley. Glaciation of the Sangre de Cristo Range has formed glacial moraine and outwash deposits that overlie the Santa Fe Formation. Alluvial deposits of sand and gravel derived from the Wet Mountains also have been deposited on the basin fill.

A resistivity section near Westcliffe (Londquist and Livingston, 1978, p. 9) indicates a thickening of the alluvial and basin-fill deposits to the west, away from the Wet Mountains. A 1,200-ft deep test well (SC02307206AAB1) was drilled along the resistivity section. The test well was completed in a confined (artesian) zone and flowed at a rate of approximately 20 gal/min. A summary of the rock types penetrated by this test well is presented by Londquist and Livingston (1978, p. 45). Resistivity sections here and in the Buena Vista-Salida basin (fig. 2) indicate the most permeable rock materials occur in the upper 1,000 ft of the basin-fill deposits.

In the Wet Mountain Valley, ground water occurs in the alluvial, glacial, and basin-fill deposits under confined and unconfined conditions. Domestic and stock wells are completed in the glacial-outwash deposits at depths ranging from 20 to 90 ft in the northern part of the valley. Glacial-outwash deposits generally are drained in the southern part of the valley and wells obtain water from the underlying basin-fill deposits. Several flowing wells have been completed in the basin-fill deposits.

Consolidated-Rock Aquifers

The upper Arkansas River basin is underlain by a variety of igneous, sedimentary, and metamorphic rocks, including latite, andesite, rhyolite, granite, shale, sandstone, limestone, conglomerate, and gneiss. All these rock types are capable of yielding water to wells or springs and thus are defined as aquifers. The areal distribution of the various consolidated-rock aquifers is shown in plate 1.

Igneous-rock aquifers of Tertiary age include both volcanic rock and intrusive rock. The volcanic rocks consist of flows, flow breccias, lahars, and tuffs and range in composition from rhyolite to latite and andesite to basalt. The greatest reported thickness is 1,500 ft near the south end of the Wet Mountains. Individual beds may range in thickness from a few feet to a few tens of feet.

Water in the volcanic rocks occurs in the interstices of the tuff and in fractures in the flows. Water also may be present in the interstices of sand and gravel units which exist between individual flows and tuffs. Yields to wells generally are less than 10 gal/min although locally yields could be several times larger. Springs may issue from the rock where saturated permeable zones intersect the land surface.

The intrusive rocks consist of quartz monzonite, granodiorite, and quartz-diorite porphyries, some of which are of Tertiary age, and some of which are partly of Tertiary age and partly of Late Cretaceous age. Water in these rocks occurs only in fractures and may be unconfined or confined, depending on the individual fracture systems. No wells are known to have been developed in these rocks because of the rugged topography associated with these intrusives rather than their potential as a water supply. As previously discussed, these rocks probably are the source of the water and heat for the hot springs which occur along the western margins of the Buena Vista-Salida ground-water basin southwest of Buena Vista. Many of these springs have been developed for commercial purposes by resort hotels. The discharge of most springs is less than 20 gal/min, but groups of springs may discharge as much as 300 gal/min. Water temperatures of the springs generally are 53° to 58°C. Hortense Hot Springs (SC01507924BDA) has a temperature of 80°C--reportedly the hottest in the State (Pearl, 1972).

Sedimentary rocks of Tertiary age include the Poison Canyon Formation and the Raton Formation, which also is of Cretaceous age. The Raton and the Poison Canyon Formations are restricted to a small structural basin that extends south of the Arkansas River between Canon City and Florence. The Poison Canyon Formation consists of massive sandstone and comglomerate as much as 550 ft thick. The Raton Formation consists of interbedded sandstone, siltstone, shale, and coal as much as 500 ft thick. Locally, both the Poison Canyon and the Raton Formations may yield small quatities of water to wells.

Sedimentary rocks of Cretaceous age are restricted almost exclusively to the area east of Canon City (pl. 1). Upper Cretaceous rocks generally are drab in color and consist primarily of shale and limestone with a few minor sandstones.

The Vermejo Formation of Cretaceous age consists of as much as 340 ft of buff to gray sandstone and interbedded gray to black carbonaceous silty shale and coal that overlie the Trinidad Sandstone. The distribution of the Vermejo Formation is restricted to a small synclinal basin south of Canon City. Several wells drilled into the Vermejo Formation yield highly mineralized water believed to come from abandoned coal mines. Seepage from mine portals was observed in several outcrops.

The Trinidad Sandstone is restricted to about 43 mi^2 in the synclinal basin south of Canon City. The Trinidad Sandstone is a light-gray to buff, medium- to fine-grained, massive sandstone, as much as 60 ft thick, that crops out in a narrow band on the west side of the basin where its attitude is nearly vertical. A few domestic wells penetrate the Trinidad Sandstone at depths of less than 200 ft near the outcrop south of the Arkansas River. Reported well yields from the Trinidad Sandstone range from 20 to 100 gal/min.

The Niobrara Formation consists of the Smokey Hill Shale Member and the Fort Hays Limestone Member. The Smokey Hill Shale Member, which consists of gray to buff gypsiferous shale as much as 700 ft thick (Scott, 1969), is not an aquifer. The Fort Hays Limestone Member consists of light-gray to chalky limestone beds separated by chalky shale partings as much as 40 ft thick. The Fort Hays Limestone Member and the underlying Codell Sandstone Member of the Carlile Shale cap most of the mesas and buttes in the plains east of the foothills, as well as the prominent escarpment along the Arkansas River. The Fort Hays Limestone produces the most water in the Penrose area (pl. 1) where it lies at or near the land surface. Water is contained in fractures and possibly in solution openings in the limestone beds. The Fort Hays Limestone is reported to yield as much as 110 gal/min.

The Bridge Creek Limestone Member of the Greenhorn Limestone consists of light-gray, thin-bedded limestone interbedded with dark-gray shale as much as 55 ft thick. The beds of limestone range in thickness from about 1 in. to about 1 ft and the shale beds may range in thickness from a few inches to several feet. The Bridge Creek Limestone Member is dense and has little permeability, but where fractures occur, the unit may yield as much as 40 gal/min of highly mineralized water to wells. The base of the Bridge Creek Limestone lies 180 to 220 ft above the top of the Dakota Sandstone. The rocks between the Bridge Creek Limestone and Dakota Sandstone are not aquifers.

Sandstones of Early Cretaceous age are the most productive consolidated-rock aquifers. The Lower Cretaceous aquifers occur in two formations--the Dakota Sandstone and the underlying Purgatoire Formation. The Dakota Sandstone is the principal source of water throughout the plains east of the mountains. This area historically is one of cattle grazing and most of the early wells were drilled to supply stock water. Water has been obtained from wells completed in the Dakota Sandstone since about 1900. As the larger cattle ranches were subdivided, the rural population and the number of wells increased. Most of the wells were completed in the upper 50 ft of the Dakota Sandstone and yielded sufficient water for stock and domestic uses. The discovery of oil in the Florence and Canon City areas resulted in exploratory drilling and greater development of the Dakota aquifer.

The Dakota Sandstone consists of a fine- to medium-grained sandstone that is interbedded with varying quantities of shale, mudstone, clay, and some lignite. Individual beds are variable in thickness and lithology. Locally, the entire formation may consist of sandstone. Stratigraphically, the Dakota Sandstone lies 450 to 500 ft below the Fort Hays Limestone Member of the Niobrara Formation.

The Purgatoire Formation consists of two members--the Glencairn Shale and the Lytle Sandstone. In some adjacent areas, the Glencairn Shale Member is correlative to the Kiowa Shale and the Lytle Sandstone Member is correlative to the Cheyenne Sandstone. The two members may not be recognizable throughout the upper Arkansas River basin because the Glencairn Shale becomes increasingly sandy toward the foothills. In the following discussions of the Lower Cretaceous aquifers, the authors have used data from a thesis by Long (1951).

The Glencairn Shale Member contains a variety of rock types; however, gray shale, sandy shale, thin-bedded sandstone, and siltstone predominate. Immediately east of Beulah, sandy sediments predominate. Several miles east of the foothills, the Glencairn is almost entirely shale.

The Lytle Sandstone Member is characteristically a massive, fine- to medium-grained sandstone containing conglomeratic lenses and thin beds of variegated siltstone. Water in the Lytle is confined by the overlying Glencairn Shale Member.

The Dakota Sandstone and the Purgatoire Formation together form an aquifer referred to in this report as the Dakota-Purgatoire aquifer. As mentioned previously, this aquifer is widely used as a dependable water supply throughout the central regions of the United States, and its potential for development in eastern Colorado is good. In outcrop areas, the Dakota-Purgatoire aquifer is unconfined. In the foothills areas, where the aquifer is upturned and forms ridges and hills, it is nearly drained. The altitude of the top of the Dakota Sandstone is shown on plate 4.

Depths to the top of the Dakota-Purgatoire aquifer range from 0 to 4,500 ft. In areas where the aquifer dips gently away from the outcrop, the depth to the top of the aquifer may be relatively small--even at large distances away from the outcrop. In areas where the beds in the outcrop are vertical or nearly vertical, the depth to the aquifer may be large even at short distances from the outcrop. West and southwest of Wetmore, where the Dakota Sandstone is nearly vertical, test holes a short distance east of the outcrop may have to be drilled as deep as 1,900 ft to reach the sandstone.

Faulting, although common in the western one-half of the area, generally does not cause displacement of the Dakota Sandstone by more than 50 ft. An exception is the major fault located east of Florence (pl. 4) where the strike is northward and the block west of the fault has been downthrown. Vertical displacement along this fault ranges from 1,500 ft to several thousand feet. The downthrown block forms a basin bounded by the fault to the east.

The rocks within this basin include several thousand feet of Pierre Shale and 1,000 to 1,500 ft of Tertiary coal-bearing deposits. The deepest part of the basin presumably contains the Tertiary beds where the Dakota Sandstone is estimated to be as deep as 4,500 ft below land surface. The depth to the top of the aquifer can be estimated for any particular location by subtracting the altitude of the top of the aquifer (pl. 4) from the altitude of land surface.

The potentiometric surface for the Dakota-Purgatoire aquifer is shown on plate 5. This map shows the altitude to which water will rise in a well completed in the aquifer and the direction of ground-water movement. Water will flow from a well at any site where the potentiometric surface is above the land surface. Yields of flowing wells range from a few gallons per minute to as much as 150 gal/min. A spring (SC02406727CBC) located between Colorado City and Rye was reported to yield several hundred gallons per minute.

Maximum yield from the unfractured Dakota-Purgatoire aquifer is bout 300 gal/min where the aquifer is fully saturated. Greater yields are obtained where the aquifer contains open fractures. In some wells, yields that were initially 30 to 40 gal/min have been increased to 90 to 120 gal/min by hydraulically fracturing the sandstones of the Dakota-Purgatoire aquifer. (The theory and process of hydraulic fracturing is described in detail by Howard and Fast, 1970). Water is pumped from the aquifer mostly for stock and domestic use in the study area. Pumping of the Pueblo West well field for irrigation and public supply probably is the largest source of discharge from the Dakota-Purgatoire aquifer.

Pre-Cretaceous Sedimentary Aquifers

Aquifers of pre-Cretaceous age, which underlie the Dakota-Purgatoire aquifer, are the Morrison Formation of Late Jurassic age, the Fountain Formation of Pennsylvanian and Permian age, and the Harding Sandstone of Ordovician age. Hydrologic data pertaining to these aquifers are sparse, probably because development of the aquifers generally is not feasible due to the great depths. Outcrops of the formations in the foothills area along the east side of the Rocky Mountains are generally void of ground water.

The Morrison Formation consists of as much as 350 ft of green, drab, or gray mudstone containing numerous lenses of freshwater limestone and beds of variegated mudstone and sandstone. As exposed on the west slope of the hogback west of Canon City, the Morrison Formation includes 150 ft of alternating sandstone and shale, 160 ft of purple and green shale, and 4 ft of prominent freshwater limestone underlain by 40 ft of pale-bluish-green massive shale and sandstone.

Yield to wells completed in the Morrison Formation is obtained from sandstone layers and from fractures in the shale and limestone. Reported yields from these wells range from 12 to 60 gal/min.

The Fountain Formation consists of as much as 4,500 ft of fractured, coarse-grained, pink to buff, arkosic and conglomeritic sandstone and shale, partly interstratified with beds of red siltstone. The arkosic sandstone beds are composed of poorly sorted angular quartz and feldspar. The Fountain Formation is exposed extensively northeast of Canon City and along the flanks of the Wet Mountains between Beulah and Wetmore. Near Beulah the estimated thickness of the Fountain Formation is 1,000 ft. East of the Front Range, few wells are completed in the Fountain Formation because of its great depth. Well SC02006704CAB was drilled to a depth of 3,000 ft and completed in the Fountain Formation. This well was reported to flow 400 gal/min in 1971, but in 1974 the flow had decreased to about 30 gal/min. An oil test at well SC02006704CCA was drilled in 1959 to a depth of 4,500 ft. This well penetrated the Fountain Formation and 20 ft of the underlying Harding Sandstone before granite was encountered at 4,497 ft.

The Harding Sandstone, the oldest sedimentary rock formation exposed in the upper Arkansas River basin, consists of thin-bedded, cross-laminated, slightly calcareous, fine-grained quartzose sandstone having a white to lavender color. Wells drilled into the Harding Sandstone generally yield less than 50 gal/min. The Harding Sandstone can be deeply buried--nearly 4,477 ft below land surface in the oil test at SC02006704CCA.

Precambrian Rocks

The crystalline rocks of Precambrian age consist of both igneous and metamorphic rocks. The igneous rocks are composed of pinkish-gray, massive to foliated, medium- to coarse-grained hornblende or biotite granodiorite; dark-gray massive to foliated hornblende-biotite quartz diorite; and coarse-grained prophyritic biotite granite. These rocks have been intruded into the older metamorphic rocks. The metamorphic rocks are composed of layered feldspathic biotite-quartz-plagioclase gneiss with some garnetiferous, hornblendic, and sillimanitic varieties. Many of the metamorphic rocks have been converted to migmatites.

Water occurs only in the fractures in the crystalline rock. The more closely spaced the fractures, the better the chance for obtaining a well with adequate yield; the further apart the fractures, the smaller the chance of obtaining a well, and usually, though not always, the well yield will be smaller. Well yields generally are less than 10 gal/min and average, perhaps, less than 5 gal/min. Well depths commonly are less than 200 to 300 ft. Usually, it is impractical to drill deeper because the extent of fracturing decreases with depth.

Movement

Surface runoff from the surrounding mountains is the primary source of water entering aquifers in the intermontane basins. Much of this water infiltrates the unconsolidated aquifers as the streams flow from the mountains onto the aquifers. Other sources of recharge include underflow from rocks of the mountains and direct precipitation on the basins. After the water infiltrates, it moves downgradient and is discharged by springs or to streams, lost to evapotranspiration, or flows out of the basins as underflow.

The consolidated-rock aquifers are recharged primarily by infiltration of streams flowing over outcrop areas or direct infiltration of precipitation. The water then moves downgradient where it is discharged by wells or springs and possibly by streams. Water also may be discharged by slow upward leakage through confining beds where confined conditions exist. The general direction of water movement in the Dakota-Purgatoire aquifer is shown by the flow lines on plate 5. The flow lines indicate that water moves toward the Arkansas River where it is discharged to flowing wells or to the river, and toward the east, outside the area of investigation.

Storage

Aquifers in the upper Arkansas River basin with significant volumes of water in storage are the unconsolidated deposits in the Leadville and the Buena Vista-Salida basins and the Wet Mountain Valley. No data are available on the storage coefficient of these deposits; however, based on lithology, 0.15 is assumed. The following table gives the area of each of the three basins and the estimated volumes of ground water in storage in the upper 200 ft of saturated material:

Basin	Area of deposits, square miles	Storage, million acre-feet
Leadville----------------	100	1.9
Buena Vista-Salida-------	200	3.8
Wet Mountain-------------	233	4.5
Total---------------	533	10.2

SURFACE WATER

The surface-water resources of the upper Arkansas River basin are vital to the economy of the area. Most of the water for agriculture is obtained by direct diversion of surface water from the Arkansas River and its tributaries rather than from pumping of ground water. Streamflow in the upper Arkansas River basin is derived from melt water from the high-altitude snowpack, direct runoff from precipitation, transmountain diversions, return flow from irrigation, water released from reservoir storage, and ground-water inflow to streams. The ground-water contributions occur as springs, streamflow gains, and mine drainage.

Table 3.--*Precipitation and evaporation stations, September 1979*

Station	Latitude	Longitude	Altitude (feet)	Years of record
		Precipitation		
Buena Vista-----------	38°51'	106°08'	7,930	71
Canon City------------	38°26'	105°16'	5,343	91
Climax----------------	39°22'	106°11'	11,350	47
Guffey 10 SE----------	38°41'	105°23'	8,200	27
Leadville 2 SW--------	39°14'	106°19'	9,938	4
Rye-------------------	37°55'	104°56'	6,790	35
Salida----------------	38°32'	106°03'	7,488	10
Westcliffe------------	38°08'	105°29'	7,860	71

Station	Latitude	Longitude	Altitude (feet)	Years of record	
				Precipitation	Evaporation
		Precipitation and Evaporation			
Pueblo Reservoir------	38°16'	104°43'	4,555	5	5
Pueblo 6 SSW----------	38°11'	104°39'	4,910	9	9
Sugar Loaf Reservoir--	39°15'	106°22'	9,738	29	29
Twin Lakes Reservoir--	39°05'	106°19'	9,300	26	[1]15

[1]Twin Lakes evaporation data not published.

Precipitation

Precipitation in the upper Arkansas River basin occurs as rainfall, snowfall, and all intermediate forms, such as hail and sleet. Because of the orographic effect of the Rocky Mountains, storms moving into Colorado from the Pacific during the winter months tend to deposit most of their moisture on the western slope of the mountains. Summer storms, which usually result from moisture brought into the area from the Gulf of Mexico by atmospheric lows forming south of the study area, generally occur on the plains east of the mountains. The distribution of mean annual precipitation in the upper Arkansas River basin for 1931-60 is shown on plate 2.

Rainfall in the summer months is characterized by intense thunderstorms or cloudbursts. These storms generally are localized, resulting in pronounced, but short-duration, runoff peaks. Precipitation from winter storms falling as snow accumulates at the higher altitudes and forms the mountain snowpack. This natural storage of water aggregates throughout the winter months and is released to ground water and to streamflow during the warmer months in late spring and early summer.

Data for 12 evaporation and precipitation stations (table 3) located within the study area (pl. 6) are published by the National Oceanic and Atmospheric Administration (National Weather Service, 1979). The monthly precipitation values at Buena Vista and at Canon City for 1979 are shown in figure 4. Measurements of snow depth and water content are made during February to May and are published by the Snow Survey Unit of the U.S. Soil Conservation Service (1972, 1978, 1979). Twelve snow courses operated in the study area during the winter of 1979 are listed in table 4 and shown on plate 6. The mean water equivalents of the snowpack at snow courses near Tennessee and Monarch Passes for February to May (1963 to 1977) are shown in figure 4.

Table 4.--*Snow courses operated by the U.S. Soil Conservation Service, 1979*

Snow course	Number	Section	Township	Range	Altitude (feet)
Bigelow Divide-------	5L03	29	22 S.	69 W.	9,350
Cooper Hill----------	6K23	13	8 S.	80 W.	11,000
East Fork------------	6K17	16	8 S.	79 W.	10,700
Four Mile Park-------	6K07	27	11 S.	81 W.	9,700
Fremont Pass---------	6K08	3	8 S.	79 W.	11,400
Garfield-------------	6L08	33	50 N.	6 E.	9,900
Hermit Lake----------	5L04	36	45 N.	12 E.	10,400
Monarch Pass---------	6L04	16	49 N.	6 E.	10,500
South Colony---------	5M13	16	24 S.	73 W.	11,140
Tennessee Pass-------	6K02	21	8 S.	80 W.	10,200
Twin Lakes tunnel----	6K03S	22	11 S.	82 W.	10,100
Westcliffe-----------	5L02	19	22 S.	73 W.	9,000

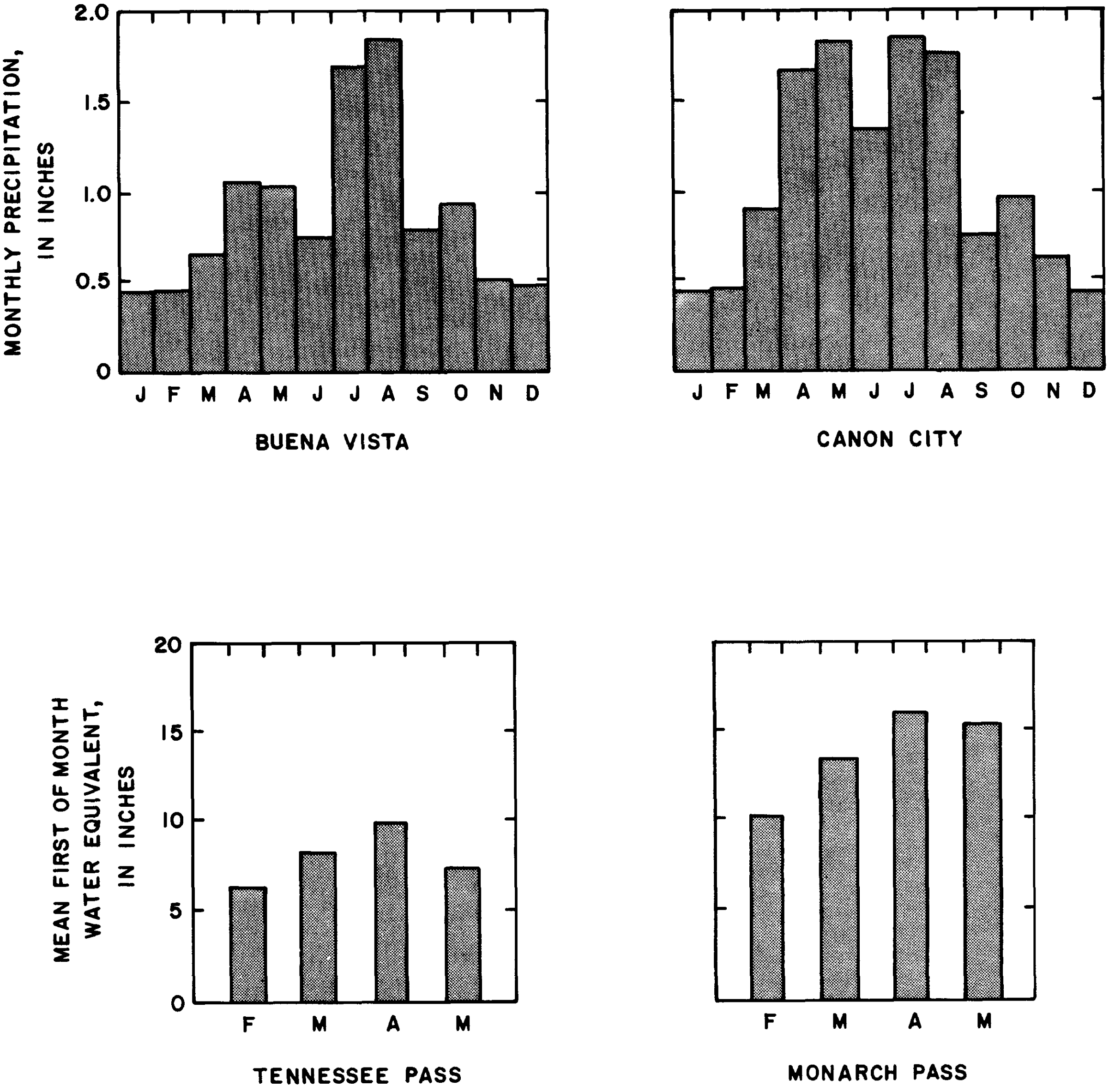

Figure 4.--Monthly precipitation at Buena Vista and Canon City, 1979, and mean first-of-month water equivalent of snow pack at Tennessee and Monarch Passes, 1963-77.

Streamflow

In September 1979, there were 26 streamflow gages in operation in the Arkansas River basin upstream from Pueblo (pl. 6). The records for 21 of these stations are published annually by the U.S. Geological Survey. Data for the other operating stations are available from the Colorado Division of Water Resources, Office of the State Engineer. Currently (1982) operating streamflow gages for which data are available are listed in table 5. In addition, records are available for 29 discontinued streamflow gages in the study area.

Springs make minor contributions to streamflow in the study area. Inspection of topographic maps of the area indicates that small springs occur in or near the channels of many tributaries. The water from some of the springs--Soda Spring in Lake County and Yellow Soda Spring in Park County--contains large quantities of dissolved minerals. Some of the larger springs are thermal (Romero and Fawcett, 1978). Examples of these are Hortense Hot Spring, Mount Princeton Hot Spring, Cottonwood Hot Springs, and Poncha Hot Spring in Chaffee County and the hot springs located near Wellsville, Swissdale, and Canon City in Fremont County (Barrett and Pearl, 1978) (pl. 6).

Several tunnels have been bored to drain mines in the Leadville and the Cripple Creek Mining Districts (Moran and Wentz, 1974). Though the contributions to the quantity of surface water from these mine drains are minor, the impact on the quality of the surface water is significant and is given special consideration later in this report. The principal mine-drainage tunnels in the study area are the Yak, draining into California Gulch, and the Leadville Drain, emptying into East Fork in the Leadville District; the Roosevelt Tunnel, discharging to Cripple Creek, and the Carlton Tunnel, draining into Fourmile Creek, in the Cripple Creek District. A fifth tunnel, the Canterbury, in the Leadville District, has been diverted into a fire main by the city of Leadville (Wright, 1961).

Transmountain Diversions

According to Colorado law, water may be appropriated and put to beneficial use any place in the State, and the use is not restricted to the watershed where it originated (Radosevich and others, 1976). Streams east of the Rocky Mountains in Colorado generally are over-appropriated, whereas there are periods of surplus water in the Colorado River basin of western Colorado. These periods generally coincide with snowmelt runoff during the spring. It has long been the practice to intercept streams draining to the Colorado River in the high mountain areas and convey those waters by canal or tunnel to the headwaters of eastward draining streams. There are four transmountain ditches and four transmountain tunnels diverting water from the Colorado River basin into the Arkansas River basin within the study area. Records are published for mine diversions, including eight import stations into the Arkansas River basin and one export station from the basin. The diversions are listed in table 6, and their locations is shown on plate 6.

Table 5.--*Streamflow-gaging stations, September 1979*

[Operating agency: A=U.S. Geological Survey; B=Colorado Division of Water Resources]

Station number	and name	Operating agency	Latitude	Longitude	Drainage area (square miles)	Period of record
07081200	Arkansas River near Leadville---	A	39°15'26"	106°20'35"	97.2	10/67.
07083000	Halfmoon Creek near Malta-------	A	39°10'20"	106°23'19"	23.6	07/46.
07083700	Arkansas River near Malta-------	A	39°10'08"	106°19'23"	228.0	10/64-09/67, 10/74.
07084500	Lake Creek above Twin Lakes Reservoir.	B	39°03'47"	106°24'26"	75.0	04/46-09/62, 10/63.
07086000	Arkansas River at Granite-------	B	39°02'34"	106°15'55"	427.0	04/10[1].
07086500	Clear Creek above Clear Creek Reservoir.	B	39°01'05"	106°16'38"	67.1	05/46.
07087200	Arkansas River at Buena Vista---	A	38°50'56'	106°07'27"	611.0	10/64.
07089000	Cottonwood Creek below Hot Springs, near Buena Vista.	A	38°48'46"	106°13'18"	65.0	10/10-09/23, 08/49.
07091200	Arkansas River near Nathrop-----	A	38°39'08"	106°03'02"	1,060	10/64.
07091500	Arkansas River near Salida------	B	38°32'45"	106°00'36"	1,218	10/09[1].
07093700	Arkansas River near Wellsville--	B	38°30'20"	105°00'21"	1,485	04/61.
07094500	Arkansas River at Parkdale------	A	38°29'14"	105°22'23"	2,548	10/45-09/55, 10/64.
07095000	Grape Creek near Westcliffe-----	B	38°11'10"	105°28'59"	320	10/24-09/61, 10/62.
07096000	Arkansas River at Canon City----	B	38°26'02"	105°15'24"	3,117	01/1888.
07096500	Fourmile Creek near Canon City--	A	38°26'11"	105°11'27"	423	10/48-09/53, 10/70[1].
07097000	Arkansas River at Portland------	B	38°23'18"	105°00'56"	4,024	05/39-09/52, 10/74.
07099100	Beaver Creek near Portland------	A	38°22'27"	104°57'49"	214	10/70.
07099215	Turkey Creek near Fountain------	A	38°36'42"	104°53'39"	13.0	05/78.
07099230	Turkey Creek above Teller Reservoir, near Stone City.	A	38°27'37"	104°49'19"	62.5	05/78.
07099235	Turkey Creek near Stone City----	A	38°26'27"	104°49'31"	71.5	05/78.
07099400	Arkansas River above Pueblo-----	B	38°16'17"	104°43'06"	4,670	10/65.
			Not Published			
1	Lake Fork below Sugar Loaf Reservoir---	B	39°15'05"	106°22'28"	-------	11/74.
2	Lake Creek below Twin Lakes Reservoir--	B	39°04'34"	106°18'35"	-------	04/68.
3	Clear Creek below Clear Creek Reservoir.	B	39°01'20"	106°14'07"	-------	1946-59--summer only, 10/69.
4	Cottonwood Creek at Buena Vista--------	B	38°50'19"	106°07'30"	-------	11/70.
5	Chalk Creek near Nathrop---------------	B	38°44'31"	106°04'56"	-------	11/68.

[1]Earlier, irregular periods of record.

Table 6.--*Transmountain diversions into and out of the Arkansas River basin upstream from Pueblo, September 1979*

[All locations are for Arkansas River basin end of conveyance structure]

Station	Diversion	Section	Township	Range	Remarks
	Transmountain diversions into the Arkansas River basin				
09061500	Columbine ditch----	9	8 S.	79 W.	From Eagle River to East Fork.
09062000	Ewing ditch--------	11	8 S.	80 W.	From Eagle River to Thayer Gulch.
09062500	Wurtz ditch--------	17	8 S.	80 W.	From Eagle River to West Tennessee Creek.
09063700	Homestake tunnel---	9	9 S.	81 W.	From Homestake Creek to Lake Fork.
09073000	Twin Lakes tunnel--	22	11 S.	82 W.	From Roaring Fork River to Lake Creek.
09077160	Charles H. Boustead Tunnel.	10	9 S.	81 W.	From Fryingpan River to Lake Fork.
09077500	Busk-Ivanhoe tunnel	20	9 S.	81 W.	From Ivanhoe Creek to Busk Creek.
09115000	Larkspur ditch-----	24	48 N.	6 E.	From Tomichi Creek to Poncha Creek.
	Transmountain diversion from the Arkansas River basin upstream from Pueblo				
07086300	Aurora-Homestake pipeline.	8	12 S.	79 W.	From Arkansas River to South Platte River.

There has been a marked increase in the capacity and the volume (fig. 5) of transmountain imports during the past 2 decades. The Twin Lakes tunnel system was modified to increase capacity, and Wurtz ditch was extended to intercept additional tributaries. The annual imports of the Homestake tunnel, completed in 1967, have averaged 28,800 acre-ft, excluding those years when the tunnel was being repaired. The Homestake project is a municipal water-supply project owned jointly by the cities of Colorado Springs and Aurora. Future plans call for extending the Homestake collection system (McCullough and Miskel, 1974).

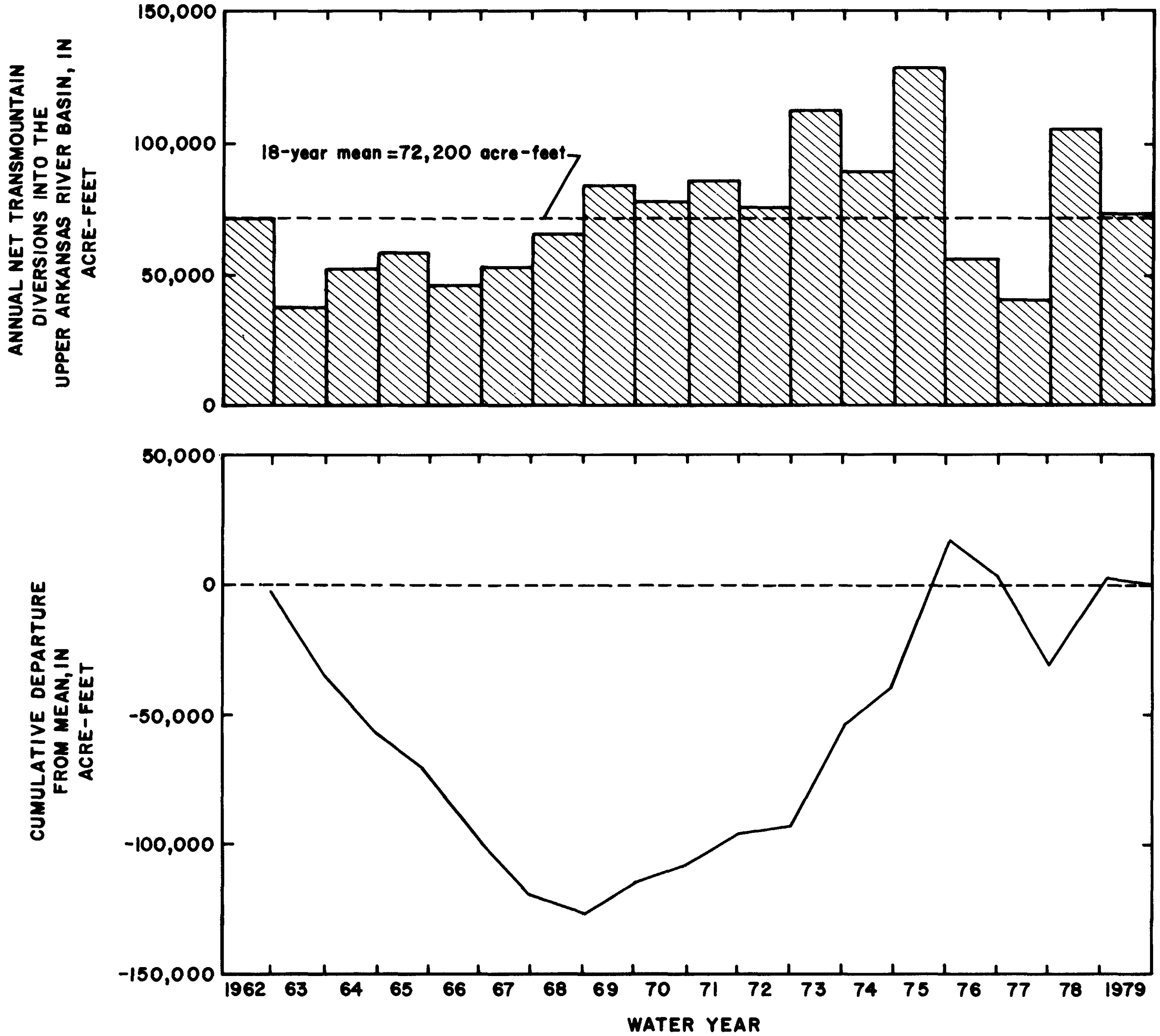

Figure 5.--Annual and cumulative departure from mean net transmountain diversions into the Arkansas River basin upstream from Pueblo Reservoir, water years 1962-79.

The construction of storage facilities and additional diversion systems in the upper basin for transmountain waters is primarily the result of the U.S. Bureau of Reclamation's Fryingpan-Arkansas Project. The Charles H. Boustead Tunnel is a principal feature of that project. Imports through this tunnel began in May 1972 and are expected to average 69,200 acre-ft per year when the project is completed (U.S. Bureau of Reclamation, 1974).

Reservoir Storage

There are numerous lakes, both natural and manmade, located in the upper Arkansas River basin. Reservoirs are necessary for regulating water supply because of the seasonal patterns of runoff in the basin. Reservoirs store spring and early summer runoff for use in meeting water demands later in the year. Lakes and reservoirs in the area with capacities greater than 1,000 acre-ft are tabulated in table 7. Some of the largest of these lakes have been constructed or enlarged within the past 15 years.

The new or enlarged reservoirs are features of the Fryingpan-Arkansas Project. New reservoirs associated with the project are Pueblo Reservoir, maximum initial capacity, 357,000 acre-ft, located on the Arkansas River in Pueblo County; and Mount Elbert forebay, an 11,530-acre-ft off-channel reservoir, lined with a polyethylene membrane to minimize seepage, which serves as a forebay to the Mount Elbert Powerplant at Twin Lakes in Lake County. Twin Lakes Reservoir, formerly owned by the Twin Lakes Reservoir and Canal Co., has been integrated into the Fryingpan-Arkansas Project, and the conservation capacity has been increased from 53,260 acre-ft to 68,000 acre-ft plus 18,000 acre-ft inactive storage and 55,000 acre-ft dead storage. Before enlargement, dead storage was 36,300 acre-ft.

Sugar Loaf Reservoir (known also as Turquoise Lake), formerly owned by the CF&I Steel Corp., has been enlarged by the U.S. Bureau of Reclamation from 17,416 acre-ft to a total storage capacity of 129,490 acre-ft, of which 120,490 acre-ft is active capacity. Storage in the enlarged Sugar Loaf Reservoir began in April 1968.

Pueblo Reservoir is the most downstream storage feature of the Frying Pan-Arkansas project. The initial capacity was 357,000 acre-ft, of which 234,000 acre-ft is designated conservation space; 30,000 acre-ft is permanent pool or inactive capacity; 66,000 acre-ft is for joint use; and 27,000 acre-ft is for flood control. The joint-use pool is used for conservation storage associated with a winter water-storage program and for supplemental flood contol. The winter water-storage program is a water-management program begun in December 1975 with the mutual consent of diverters downstream from the reservoir. Its purpose is to store enough water to satisfy water rights during the winter months for release in mid-to-late summer when crop demands are great and snowmelt runoff and precipitation are minimal. Storage in Pueblo Reservoir began on January 9, 1974; the dam was officially completed in August 1975.

Table 7.--*Lakes and reservoirs with capacities greater than 1,000 acre-feet*

[Sources of data: Skinner, 1965; Londquist and Livingston, 1978; W. C. Kregger, U.S. Bureau of Reclamation, written commun., 1979; and R. W. Jesse and C. J. Kuiper, Office of the State Engineer, July 1, 1978, tabulation listing of all decreed water rights in Water Division 2]

Lake or reservoir	Location[1]			Drainage	Operator	Total capacity, in acre-feet
	Section	Township	Range			
Sugar Loaf (Turquoise Lake)	19	9S	80W	Lake Fork	U.S. Bureau of Reclamation	129,432
Mt. Elbert Forebay	8	11S	80W	Off Channel	U.S. Bureau of Reclamation	11,530
Twin Lakes	21	11S	80W	Lake Creek	U.S. Bureau of Reclamation[2]	141,000
Clear Creek	8	12S	79W	Clear Creek	Pueblo Board of Water Works	11,400
DeWeese	20	21S	72W	Grape Creek	DeWeese Dye Ditch and Reservoir Co-	1,772
Wrights (Mt. Pisgah)	31	14S	70W	Fourmile Creek	Catlin Canal Co	2,743
Brush Hollow	30	18S	69W	Brush Hollow[3]	Beaver Park Co	4,186
Colorado Springs No. 4	32	14S	68W	Beaver Creek	City of Colorado Springs	1,965
Colorado Springs No. 5	4	15S	66W	Beaver Creek	City of Colorado Springs	2,050
Victor Bison Park	11	15S	69W	Beaver Creek	City of Victor	1,148
Rosemont-Penrose	23	15S	68W	Beaver Creek	Broadmoor Hotel	1,229
Skagway	30	16S	68W	Beaver Creek	Southern Colorado Power Co	3,275
Teller	31	18S	67W	Turkey Creek	Fort Carson	4,629
Pueblo	36	20S	66W	Arkansas River	U.S. Bureau of Reclamation	357,000
Lake Minnequa	11	21S	65W	Salt Creek[3]	CF&I Steel Corp	1,377
Reservoir No. 2	34	21S	65W	Salt Creek[3]	CF&I Steel Corp	2,896
Reservoir No. 3	33	21S	65W	Salt Creek[3]	CF&I Steel Corp	8,615
Lake Isabel	6	24S	69W	St. Charles River	U.S. Forest Service	1,069

[1]Refers to location of dam or outlet.
[2]Transferred from Twin Lakes Reservoir and Canal Co.
[3]Water from source other than drainage where reservoir is located.

End-of-month contents for Turquoise Lake near Leadville and Pueblo Reservoir near Pueblo are published by the U.S. Geological Survey (1979). Data on the contents of other reservoirs in the study area are available from the Colorado Division of Water Resources, Office of the State Engineer.

Colorado water law requires that, on the order of the Colorado State Engineer, releases be made from water in storage from each streambed reservoir in such quantities as are necessary to prevent depletion of the natural flow of the stream by evaporation from the water surface of the reservoir (Radosevich and others, 1975). For this reason, evaporation pans are located at or near all the major instream reservoirs in the basin, and the appropriate quantity of water lost to evaporation is offset by a release of water owned by the reservoir operators.

Streamflow Characteristics

Streamflow in the upper Arkansas River basin is characterized by high spring and early summer runoffs resulting from snowmelt and relatively moderate flows for the remainder of the year. Regulation of water supply by storage, import, export, and diversion onto the land have modified these characteristics, but the general pattern of seasonal variation persists.

The streamflow-gaging station, 07083000 Halfmoon Creek near Malta, is a U.S. Geological Survey Hydrologic Bench-Mark Station which monitors the drainage from 23.6 mi^2 of mostly forested terrain. The flow past this gage is natural, meaning there is no antecedent regulation or diversion. The record at this station is therefore used to illustrate unregulated flow in the upper Arkansas River basin. Because of the high altitude of this station (9,830 ft), the snowmelt-runoff peak may begin later than at gages further downstream. A hydrograph of daily streamflow for Halfmoon Creek near Malta for a typical water year, 1973, is shown in figure 6.

The annual variation of streamflow during water years 1962-79 for gage 07083000 Halfmoon Creek near Malta is shown in figure 7. That figure compares 18 years of annual recorded flow with the cumulative departure from the 18-year average annual flow. A comparison of that record with a record of precipitation at Twin Lakes Reservoir (fig. 8) and the record of April 1 water equivalent for the snow course at Tennessee Pass (fig. 9) for the same period shows the relationship between snowmelt, precipitation, and distribution of runoff for an unregulated stream.

The streamflow gage 07093700 Arkansas River near Wellsville, is located immediately downstream from Salida and measures the runoff from a drainage basin of 1,485 mi^2. The watershed varies from forested areas of the Continental Divide on the west and the Mosquito Range on the east, to the broad alluvial valleys of the Leadville and the Buena Vista-Salida basins. A hydrograph showing the mean daily flow for a typical water year, 1973, of the Arkansas River near Wellsville is shown in figure 10. The annual discharge and cumulative departure for water years 1962-79 are shown in figure 11. From the Wellsville gage to Canon City, the Arkansas River flows through the steep-walled Arkansas River canyon.

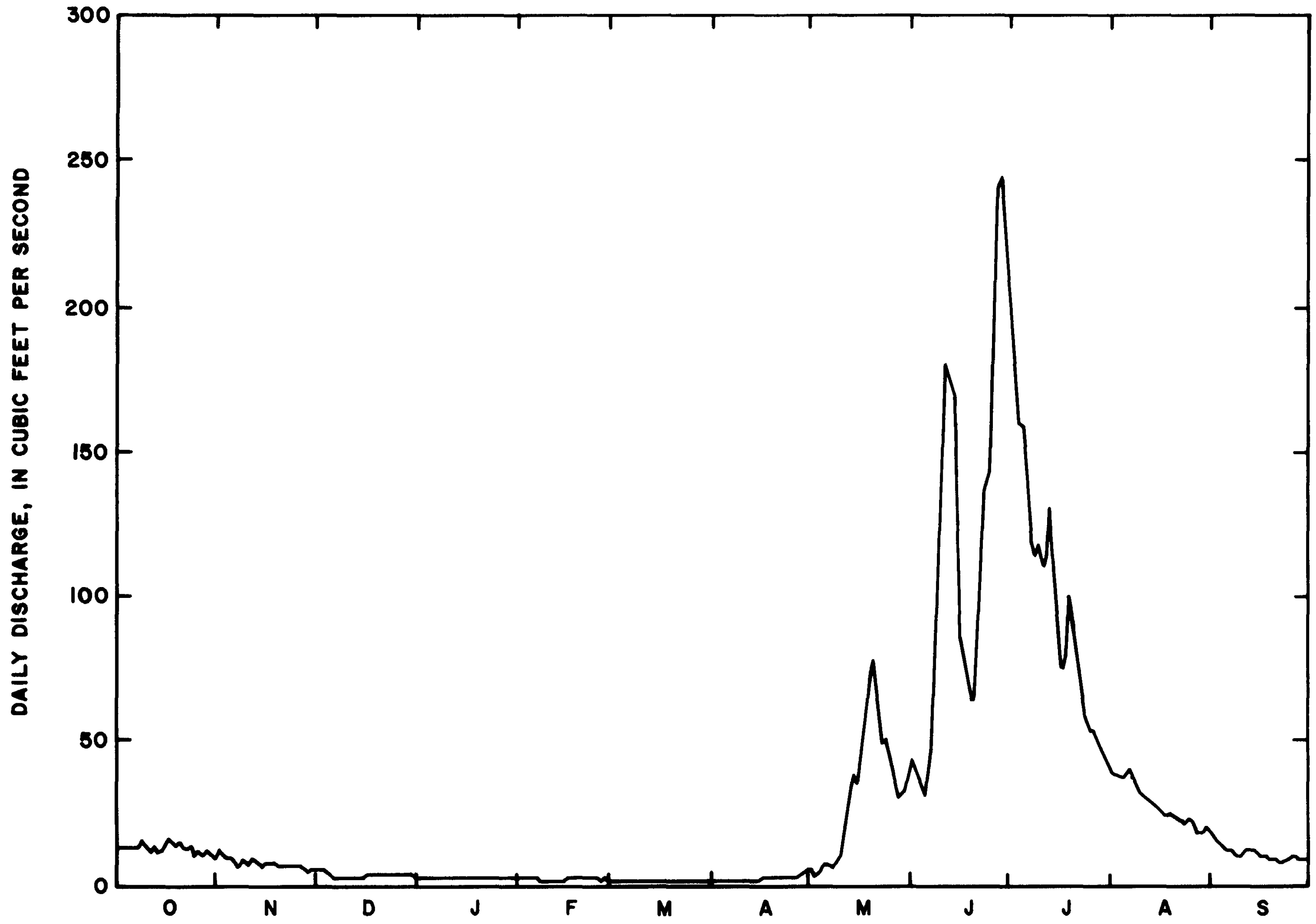

Figure 6.--Daily streamflow at gage 07083000, Halfmoon Creek near Malta, water year 1973.

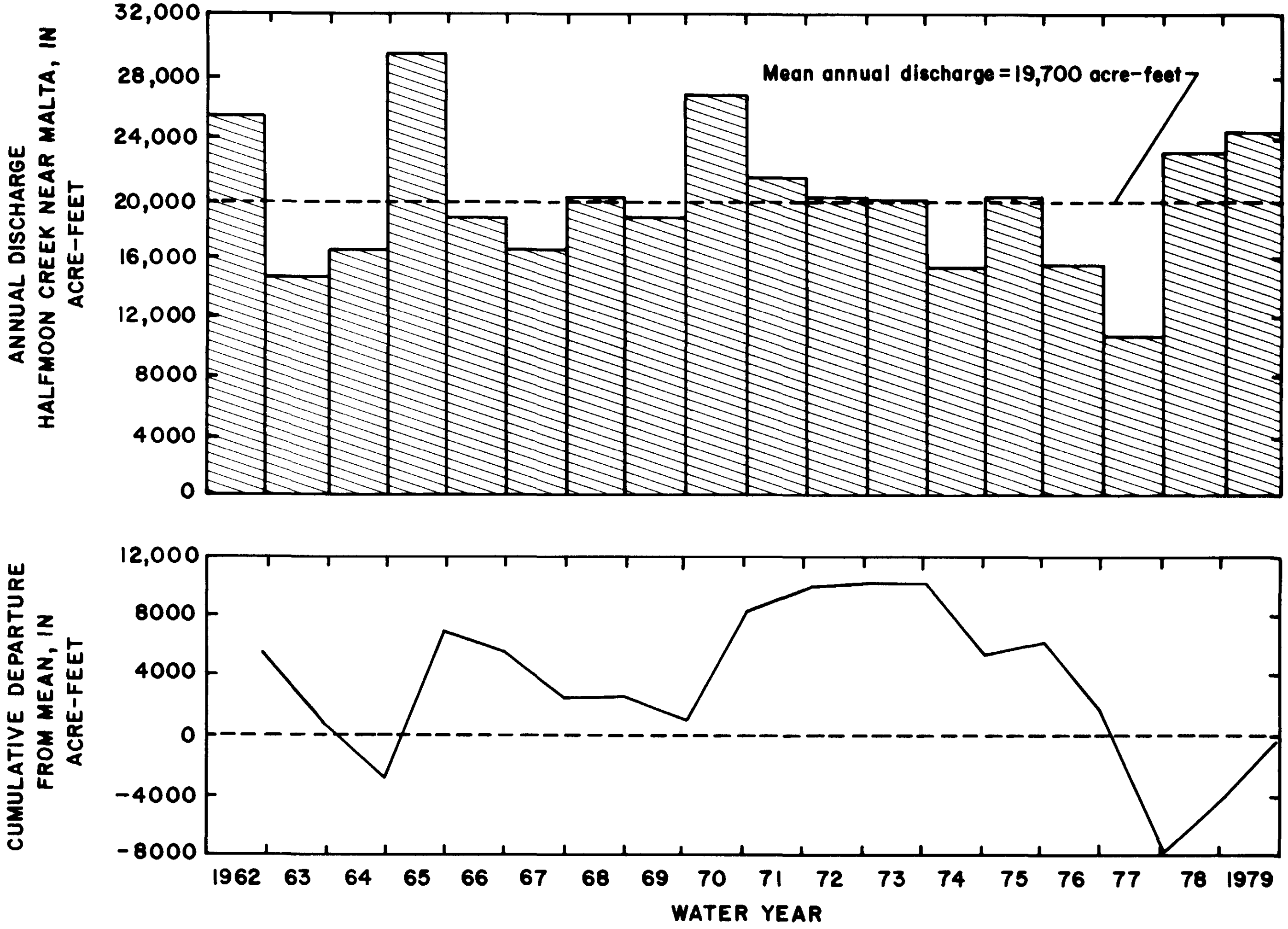

Figure 7.--Annual and cumulative departure from mean discharge at gage 07083000, Halfmoon Creek near Malta, water years 1962-79.

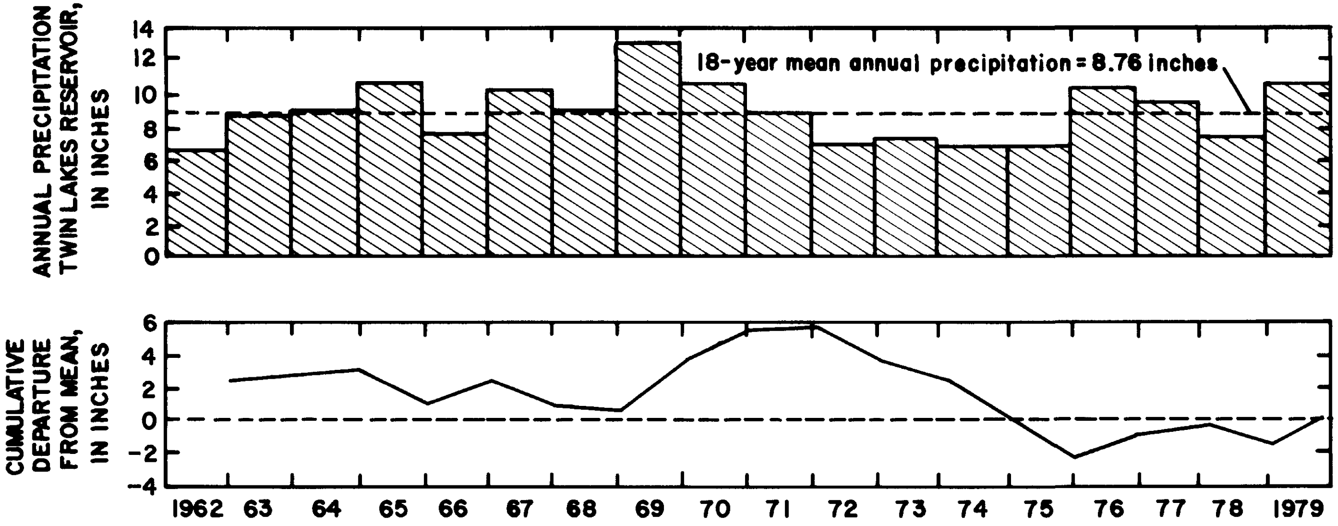

Figure 8.--Annual precipitation and cumulative departure from mean at Twin Lakes Reservoir, 1962-79.

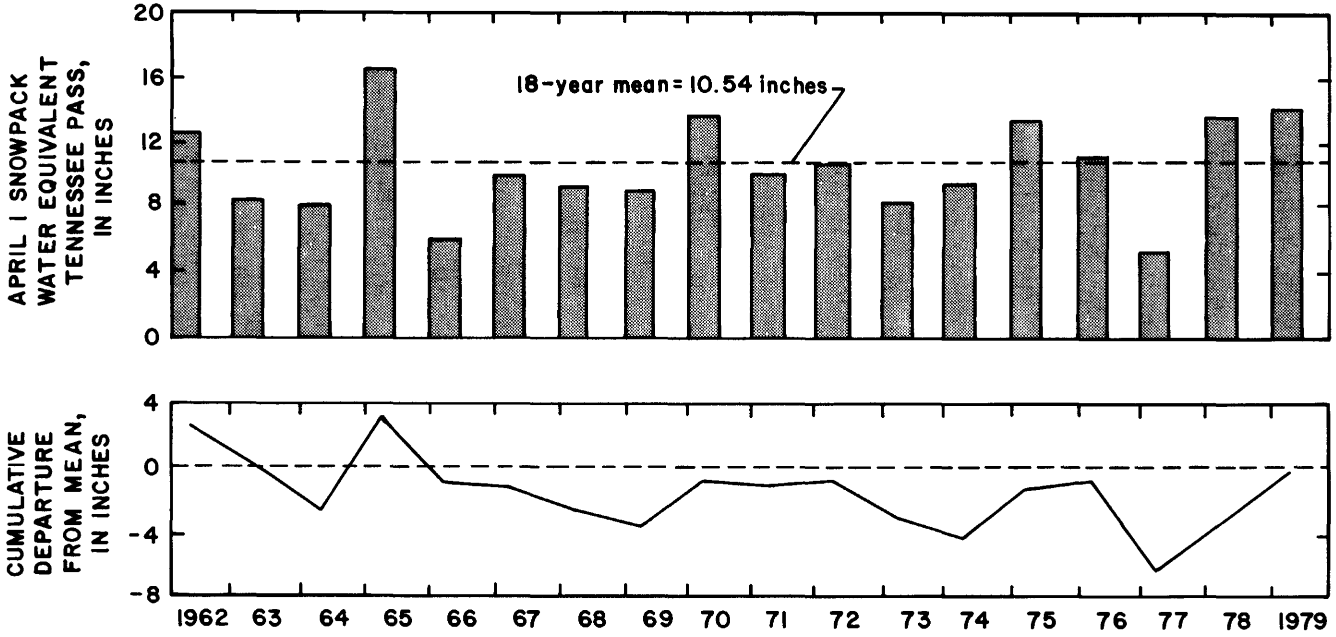

Figure 9.--April 1 snowpack water equivalent and cumulative departure from mean for Tennessee Pass snow course, 1962-79.

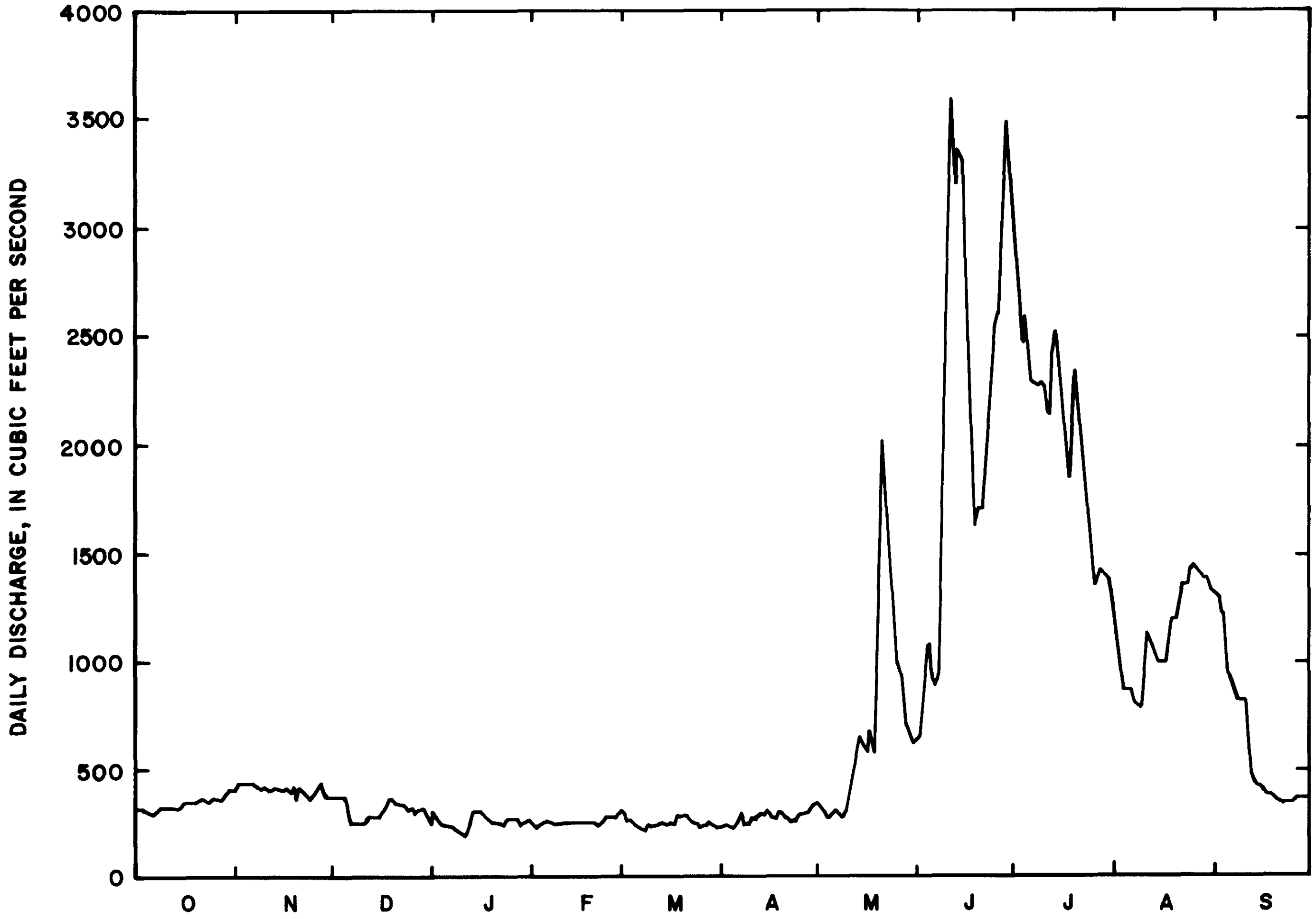

Figure 10.--Daily streamflow at gage 07093700, Arkansas River near Wellsville, water year 1973.

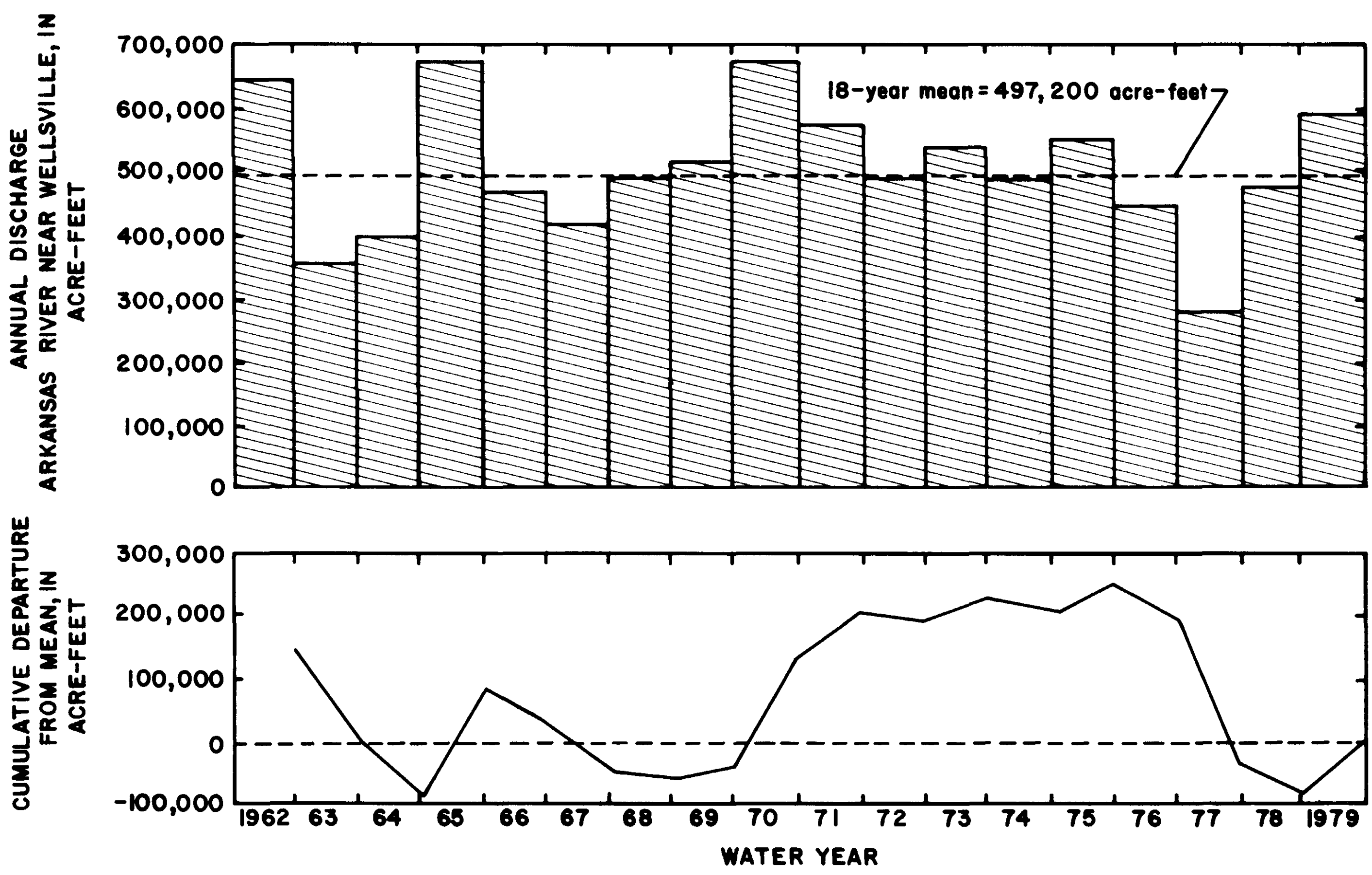

Figure 11.--Annual and cumulative departure from mean discharge at gage 07093700, Arkansas River near Wellsville, water years 1962-79.

The streamflow gage 07096000 Arkansas River at Canon City, is located just downstream from the point where the Arkansas River exits from the Royal Gorge onto the Canon City Embayment. The Canon City gage measures the runoff from 3,117 mi^2, including the drainage upstream from the Wellsville gage, the area north of the Arkansas River and south of South Park, and the Wet Mountain Valley. (The surface-water resources of the Wet Mountain Valley are thoroughly discussed in a report by Londquist and Livingston, 1978). The mean daily flow for a typical water year, 1973, is shown in figure 12, and the annual discharge and cumulative departure for water years 1962-79 is shown in figure 13.

The natural flow of the Arkansas River at the gages near Wellsville and at Canon City is affected by transmountain diversions, storage reservoirs, power developments, diversions for irrigation, and return flows from irrigated areas. The irrigated area upstream from the Canon City gage is about 56,000 acres, including 26,000 acres of irrigated land upstream from the Wellsville gage.

Flow-duration curves for streamflow gages 07083000, Halfmoon Creek near Malta (water years 1949-79); 07093700, Arkansas River near Wellsville (water years 1962-79); and 07096000, Arkansas River at Canon City (water years 1889-1979) are shown in figure 14. These curves indicate the percentage of time that a specified discharge is equaled or exceeded and describes the flow characteristics of a stream or streams through a range of discharge without regard to the sequence of occurrence. The comparatively steep slope of the flow-duration curve for Halfmoon Creek is characteristic of an unregulated stream affected primarily by ice during winter months and rapid flows during rainfall or snowmelt. In contrast, the more gentle profiles of discharge at Wellsville and Canon City indicate regulation by upstream reservoirs and ground water during periods of low flow.

Direct diversions of surface water from the Arkansas River and its tributaries in the study area are used for municipal supplies, industry, power generation, and irrigation. Surface water provides all or part of the supply for 13 municipalities in the upper Arkansas River basin. Water for industrial use is withdrawn from the Arkansas and St. Charles Rivers by the CF&I Steel Corp. for use in their Pueblo steel mill (Adkins, 1962). Direct diversions of water for power generation will increase in the future when the Mount Elbert Powerplant at Twin Lakes Reservoir becomes operational, but this is a nonconsumptive use and the water will be returned to the river system; some consumptive use occurs at the Canon City fossil-fuel powerplant.

Irrigation constitutes the largest direct diversion of surface water. In the Leadville and the Buena Vista-Salida basins, the land is used to grow hay with flood-type irrigation. Truck farming predominates in the area around Canon City. Fruit orchards, wheat, corn, hay, and alfalfa also are grown in this downstream reach. Storage, diversion, and other forms of regulation of water generally result in water loss from the system. Evaporation of impounded water in reservoirs and loss of water during conveyance in natural channels are additional examples.

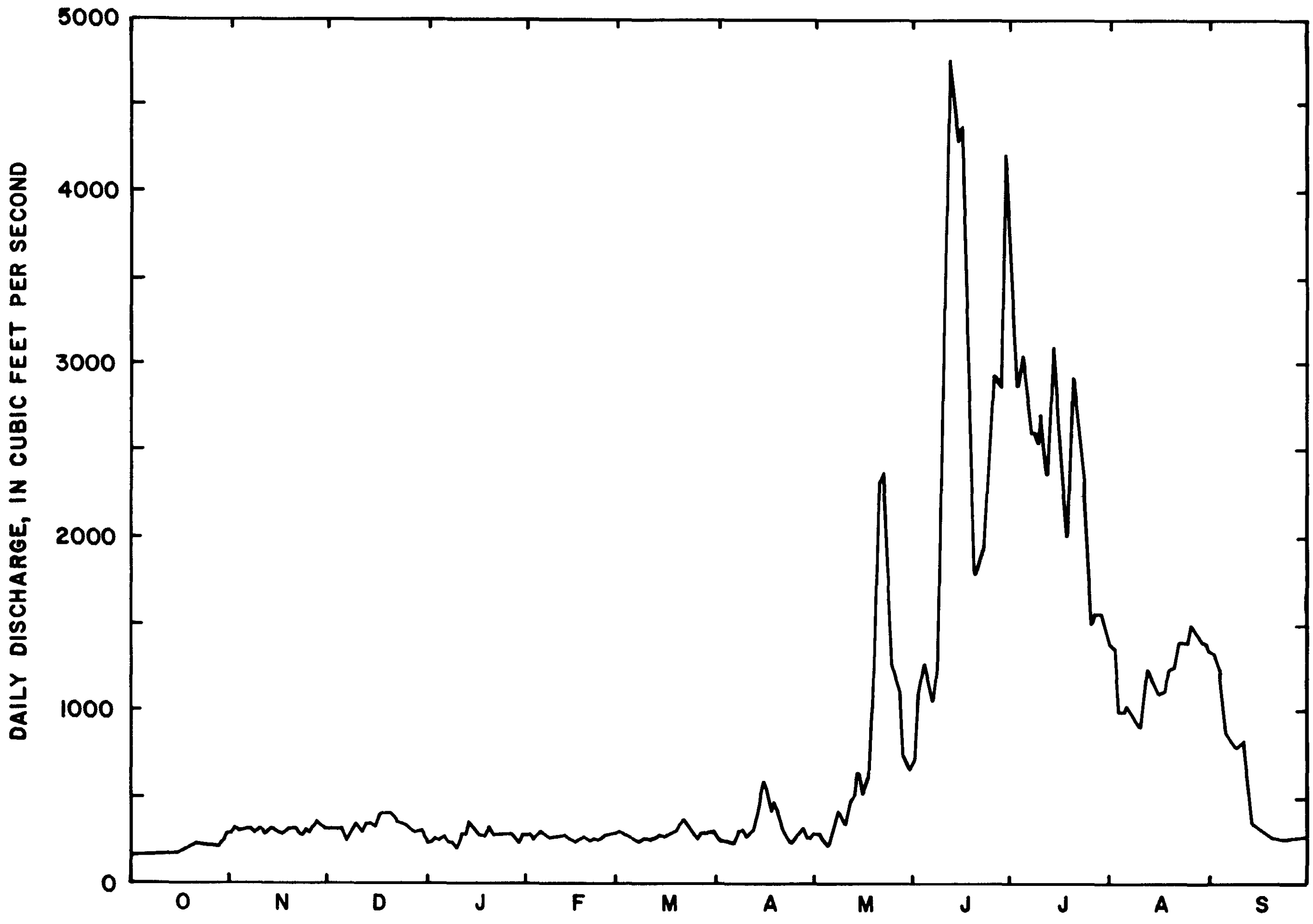

Figure 12.--Daily streamflow at gage 07096000, Arkansas River at Canon City, water year 1973.

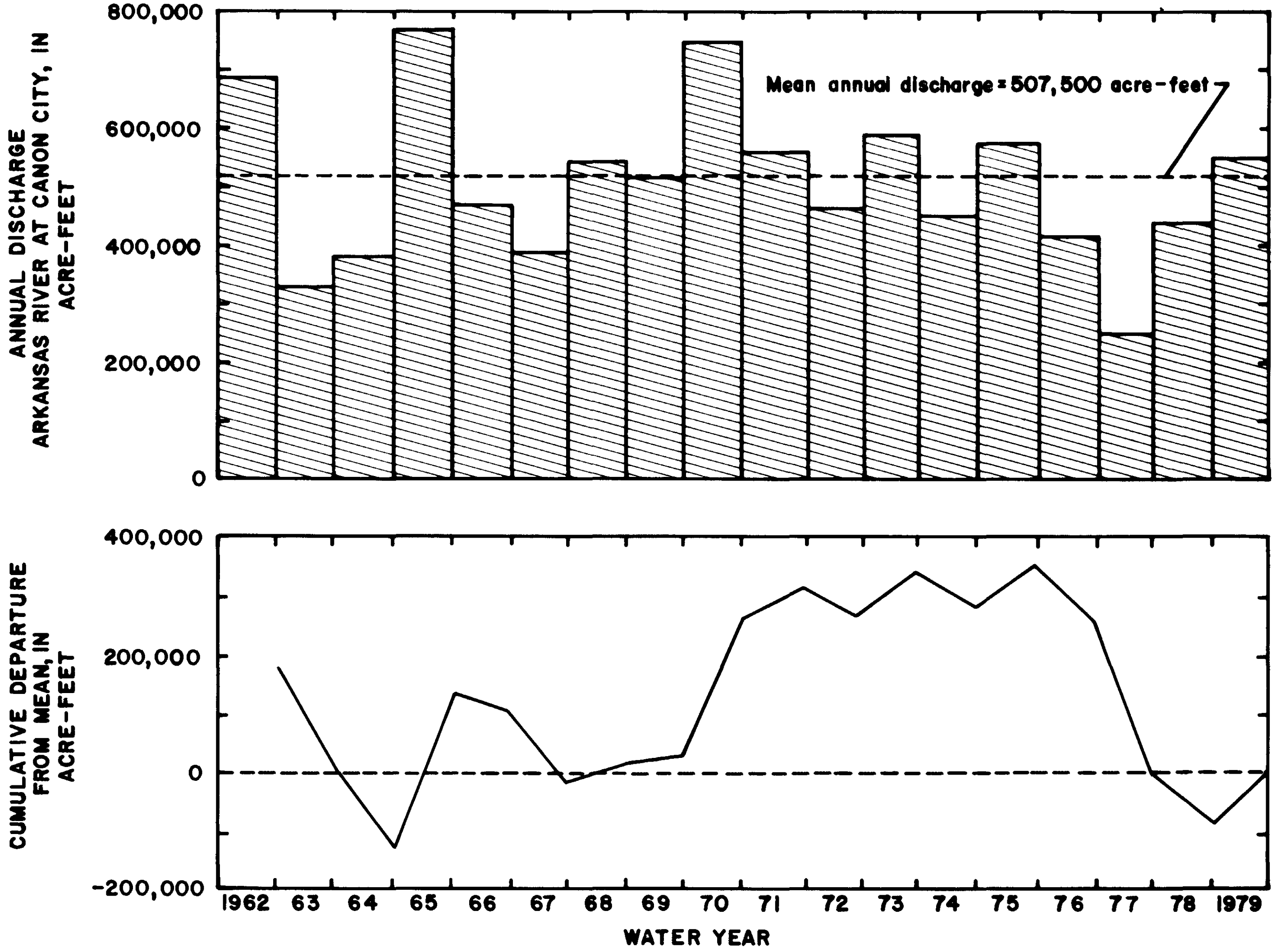

Figure 13.--Annual and cumulative departure from mean discharge at gage 07096000, Arkansas River at Canon City, water years 1962-79.

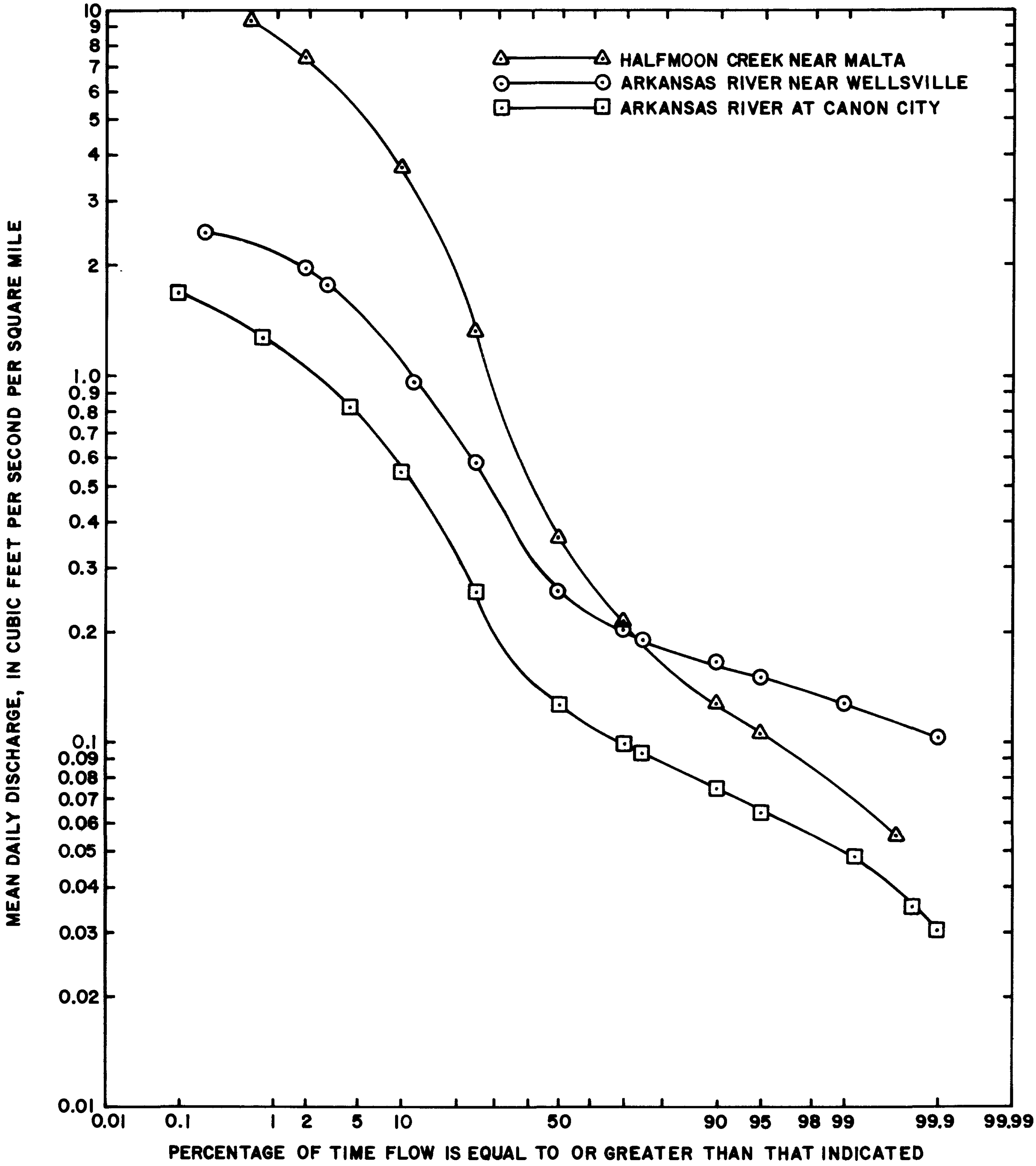

Figure 14.--Flow-duration curves for streamflow at gage 07083000, Halfmoon Creek near Malta, water years 1947-79; gage 07093700, Arkansas River near Wellsville, water years 1962-79; and gage 07096000, Arkansas River at Canon City, water years 1889-1979.

When river-deposited alluvium and the river are hydraulically connected, an interchange of water is possible. Gain-loss studies conducted to evaluate transit losses of reservoir releases (Livingston, 1973) indicate the Arkansas River is a gaining stream through most of the study area. The data shown in figure 15 are adapted from that study and show the river to be gaining except for the short reach between streamflow gages 07091500, Arkansas River at Salida; and 07093700, Arkansas River near Wellsville.

Owners of reservoirs or transmountain diversions are permitted to convey water in natural stream channels to downstream delivery points. For the protection of all water rights along the stream, compensation must be made for any losses of water that may occur during conveyance. These transit losses are determined and assessed by the Colorado State Engineer (Radosevich and others, 1975). In the upper Arkansas River basin, a transit loss of 0.07 percent per mile was established by court action (Sunnyside Park Ditch vs. M. S. Hindelider, State Engineer; Court Case No. 3345; 1944-45). More recent transit-loss studies by the U.S. Geological Survey do not support the fixed value of 0.07 percent per mile (Livingston, 1973). The studies indicate the volume of transit loss varies according to antecedent river conditions, volume and duration of each release, and distance from point of release to point of diversion.

WATER QUALITY

Ground Water

Movement of water is accompanied by continual changes in its chemical quality. As water from rain and melting snow infiltrates and percolates through the soil to the underlying aquifers, it immediately begins to dissolve materials in the soil and rocks. The quantity and character of the material dissolved depends on the quantity and quality of the infiltrating water, the chemical compsition of the soil and rocks, the rate and distance of water movement, and the temperature and pressure in the aquifer. In addition to dissolution of soil and rock material, other processes such as ion exchange, oxidation and reduction, and adsorption and desorption may further affect ground-water quality.

Many of the factors that determine ground-water quality show great variation from aquifer to aquifer and, at times, within the same aquifer. These variations result in large differences in ground-water quality, as illustrated by the graph of dissolved-solids concentrations in water from selected aquifers (fig. 16). The concentration of dissolved solids is often used as an overall indicator of water quality. In general, water with a smaller dissolved-solids concentration is considered to be of better quality than water with a larger concentration.

A more useful approach to evaluating water quality is based on the intended use of the water. Water of a quality suitable for irrigation or stock watering may not be suitable for drinking. The major uses of ground water in the upper Arkansas River basin are for domestic or municipal supplies and for agricultural use, including both irrigation and stock watering.

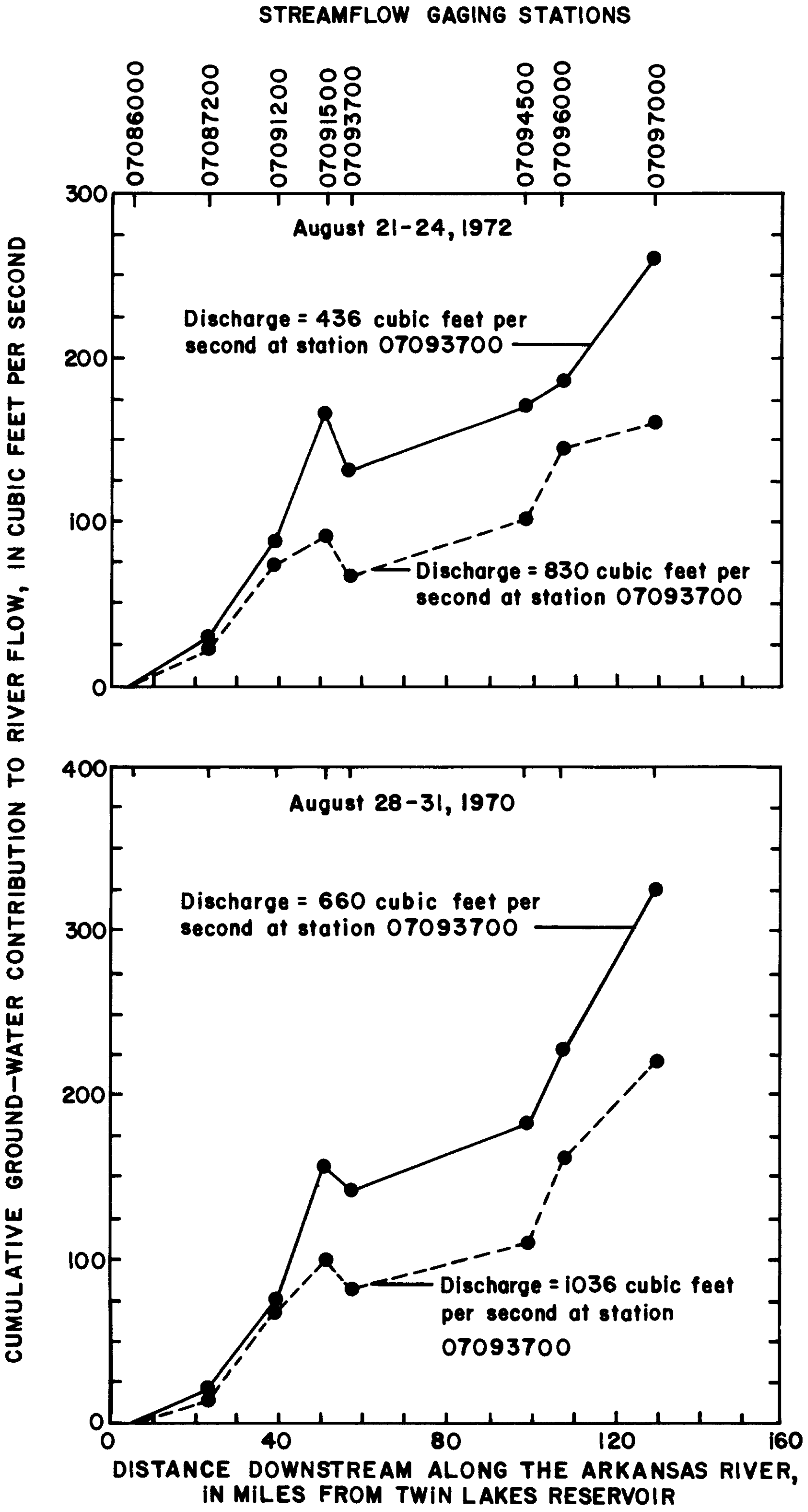

Figure 15.--Gains and losses in streamflow, gage 07086000, Arkansas River at Granite, to gage 07097000, Arkansas River at Portland, and discharge at gage 07093700, Arkansas River near Wellsville. Modified from Livingston (1973).

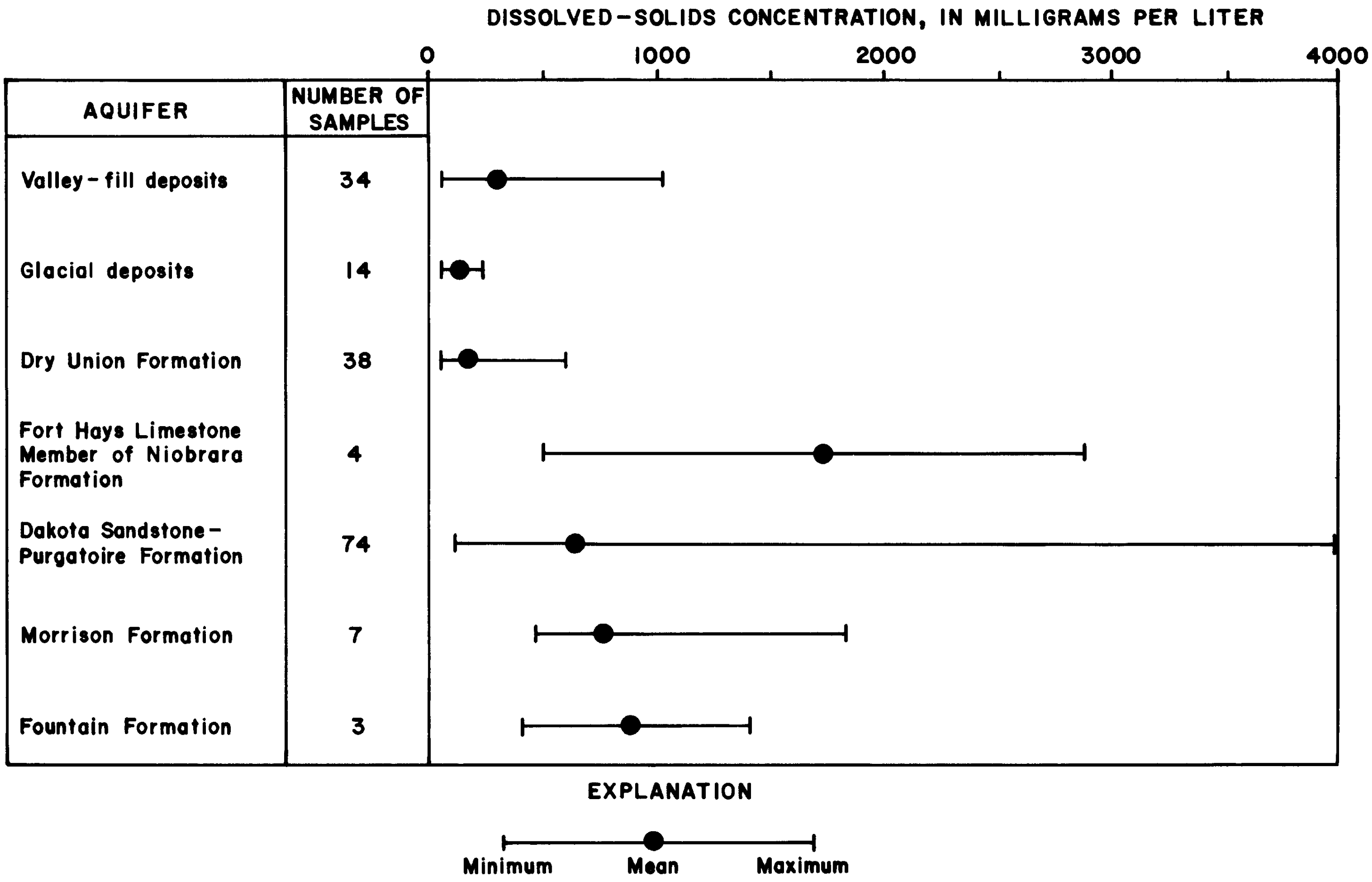

Figure 16.--Range and mean values of dissolved-solids concentrations in water from selected aquifers.

Criteria used for evaluating water for domestic or municipal supply are shown in table 8. Additional water-quality constituents, including other trace metals, pesticides, and radiochemical constituents, are of interest in drinking water but were not evaluated because of the reconnaissance nature of this study. Criteria used in this report to evaluate water for agricultural uses are based on dissolved-solids concentrations, specific conductance, and sodium-adsorption ratio.

The following evaluation of the chemical quality of ground water is based on chemical analyses of water from 194 wells and springs in 18 aquifers. The location of wells and springs sampled are shown on plate 7 and the resulting water-quality data are tabulated in the Supplemental Information section. The chemical quality of ground water in the Wet Mountain Valley has been discussed previously by Londquist and Livingston (1978).

Valley-Fill Deposits

The chemical quality of water produced from valley-fill deposits in the study area shows wide variations. Dissolved-solids concentrations of the ground water sampled ranged from 6.5 to 1,030 mg/L (milligrams per liter) (fig. 17). The smallest dissolved-solids concentrations generally occurred in water from wells completed in valley-fill deposits paralleling the Arkansas River and its tributaries in Lake and Chaffee Counties. The dissolved-solids concentration of water from wells completed in the valley-fill deposits along the main stem of the Arkansas River generally increases in the down-stream direction (fig. 17). High dissolved-solids concentrations in water from wells near Leadville probably result from degradation by mine drainage.

Water from most wells completed in the valley-fill deposits are of a calcium or calcium magnesium bicarbonate type. Several wells near Leadville, however, contain water with sulfate as the dominant or codominant anion. In the study area, sulfate is the dominant anion in mine-drainage water. Its presence in large concentrations in water from these wells is further evidence of degradation by mine drainage. Well SC01507924BDD near Mount Princeton Hot Springs also produces water with sulfate as the major anion. Water from this well also contains large concentrations of sodium and fluoride and has a temperature of 63°C.

The suitability of water produced from the valley-fill deposits for domestic or municipal supply is summarized in table 9 which shows the number and percentage of water samples from the valley-fill deposits which exceeded the drinking-water-quality criteria shown in table 8. The data indicate that the most common drinking-water-quality problems in water produced from these deposits are excessive dissolved solids, hardness, and sodium. Because only one well-water sample from the valley-fill deposits was analyzed for mercury, it is not known if mercury is a water-quality problem in other locations where these deposits are used as a water supply.

Table 8.--*Criteria used in evaluation of water suitability for domestic or public supply*

Constituent	Units	Criteria[1]	Type of criteria[2]	Reason for criteria
pH	standard pH units	6.5-8.5	Secondary drinking-water regulation[3]	pH values outside this range may cause corrosion of pipes and difficulties in water-treatment processes.[3]
Dissolved solids	milligrams per liter	500	Secondary drinking-water regulation[3]	Water with greater concentrations of dissolved solids may have objectionable mineral taste.[3]
Hardness	milligrams per liter as $CaCO_3$	180	No formal criterion	Waters with greater concentrations of hardness are considered very hard. Water of the following concentration ranges are classified as follows: 0-60 milligrams per liter, soft; 61-120 milligrams per liter, moderately hard; 121-180 milligrams per liter, hard; greater than 180 milligrams per liter, vary hard.[4]
Sodium	milligrams per liter	20	No formal criterion	Persons on a diet of very restricted sodium intake should not consume waters with concentrations greater than the criteria.[5]
Sulfate	milligrams per liter	250	Secondary drinking-water regulation[3]	Waters with greater concentrations may cause objectionable tastes, have a laxative effect on new users, and contribute to scale in boilers.
Chloride	milligrams per liter	250	Secondary drinking-water regulation[3]	Waters with greater concentrations may have a salty taste.[3]
Fluoride	milligrams per liter	[6]ranges from 1.8 to 2.4	Primary drinking-water regulation[7]	Waters with greater concentrations may cause mottling of teeth.[8]
Nitrate	milligrams per liter as nitrogen	10	Primary drinking-water regulation[7]	Waters with greater concentrations may cause methemoglobinemia (blue-baby disease) when used for infant feeding.[8]
Copper	micrograms per liter	1,000	Secondary drinking-water regulation[3]	Water with greater concentrations may cause objectionable tastes.[3]
Iron	micrograms per liter	300	Secondary drinking-water regulation[3]	Water with greater concentration may cause objectionable tastes and cause stains on laundry or porcelain.[3]
Lead	micrograms per liter	50	Primary drinking-water regulation[7]	Waters with greater concentrations may cause lead poisoning.[8]
Manganese	micrograms per liter	50	Secondary drinking-water regulation[7]	Waters with greater concentrations may cause objectionable tastes and cause stains on laundry or porcelain.[2]
Mercury	micrograms per liter	2	Primary drinking-water regulation[7]	Waters with greater concentrations may cause mercury poisoning.[8]
Selenium	micrograms per liter	10	Primary drinking-water regulation[7]	Waters with greater concentrations may cause selenium toxicity.[8]
Zinc	micrograms per liter	5,000	Secondary drinking-water regulation[3]	Waters with greater concentration may cause objectionable tastes.[3]

[1]Value which should not be exceeded, unless a range is given.

[2]Primary drinking water regulations are based primarily on anticipated health effects, and secondary drinking-water regulations are based primarily on the esthetic character of the water. While no formal criteria exist for hardness and sodium, information is included here because of widespread interest in these constituents.

[3]U.S. Environmental Protection Agency (1977).

[4]Durfor and Becker (1964).

[5]National Academy of Sciences, National Academy of Engineering (1972).

[6]Standard is dependent on average maximum air temperature and ranges in the study area from 1.8 milligrams per liter at Pueblo to 2.4 milligrams per liter at Leadville.

[7]Colorado Department of Health (1977).

[8]U.S. Environmental Protection Agency (1976a).

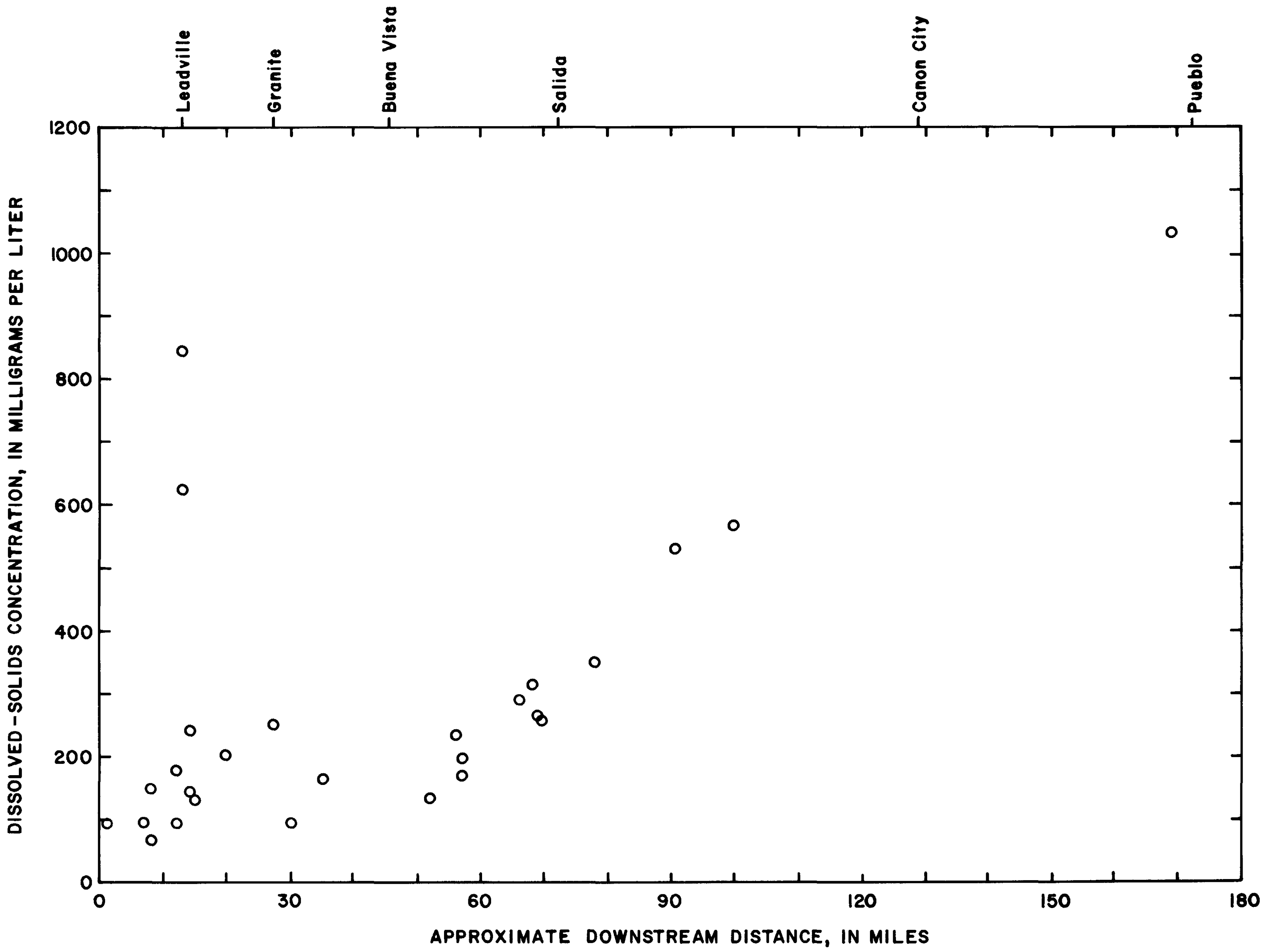

Figure 17.--Downstream increase in dissolved-solids concentrations of water from wells completed in valley-fill deposits along the Arkansas River.

Table 9.--*Number and percentage of water samples from selected aquifers that did not meet criteria of suitability for domestic or public supply*

[N=number, P=percentage, NS=no samples analyzed; criteria of suitability for domestic use or public supply are listed in table 8]

Aquifer	Number and percentage of water samples which did not meet criteria for domestic or public supply for indicated parameters																									
	pH		Dissolved solids		Hardness		Sodium		Chloride		Fluoride		Nitrate		Copper		Iron		Lead		Manganese		Mercury		Selenium		Zinc	
	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P
Valley-fill deposits--	2	6	6	18	12	35	9	26	0	0	2	6	1	3	0	0	1	3	0	0	2	6	1	100	0	0	0	0
Glacial deposits--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NS		0	0	NS		0	0	NS		NS		NS	
Dry Union Formation-	3	8	1	3	6	16	8	21	0	0	2	5	0	0	0	0	1	3	0	0	0	0	0	0	NS		0	0
Dakota-Purgatoire	5	6	40	53	52	69	57	77	0	0	5	7	4	5	0	0	43	58	0	0	47	63	1	25	4	40	3	5
Morrison Formation-	1	14	5	71	5	71	7	100	0	0	0	0	0	0	0	0	2	29	0	0	3	43	NS		NS		1	16

The suitability of water from valley-fill deposits for irrigation is dependent on several variables, the most important of which are the quality of the applied water, the type of soil and crops to be irrigated, and the irrigation practices used. A diagram used for classification of irrigation water, based on the sodium-adsorption ratio (SAR) and on specific conductance (the ability of water to conduct an electrical current), is shown in figure 18. This diagram is a useful tool in predicting potential sodium and salinity hazards of water for irrigation. The diagram has 16 different categories for classifying irrigation water, which are summarized in table 10. Waters produced from valley-fill deposits plot in the low-sodium hazard area of the diagram and should not present a sodium hazard when used for irrigation. Water samples from several wells in Pueblo County and near Leadville plot in the C3 classification for specific conductance. Irrigation with these waters may require the implementation of special management practices outlined in table 10.

Water produced from the valley-fill aquifer commonly is used for watering farm animals. These stock generally can tolerate very large concentrations of dissolved solids. Studies have shown that chickens, swine, cattle, and sheep can tolerate waters with dissolved-solids concentrations in water as large as 15,000 mg/L (U.S. Environmental Protection Agency, 1976b, p. 208). Based on dissolved-solids concentrations, water from the valley-fill aquifer and from all other aquifers sampled during this study are suitable for stock watering.

As mentioned above, specific conductance can be used as a partial indicator of irrigation-water quality. Specific conductance also is a very useful indicator of the concentration of the major dissolved chemical constituents, such as chloride, dissolved solids, hardness, sodium, or sulfate. If sufficient data are available for a given aquifer or stream, relationships commonly can be developed between specific conductance and the major dissolved chemical constituents in the water. These relationships allow estimates to be made of the major dissolved chemical constituents based on the simple and inexpensive measurement of specific conductance. Such relationships have been developed for water produced from the valley-fill deposits and several other aquifers in the study area. The relationships for water produced from the valley-fill deposits are illustrated in figures 19 and 20 and are given mathematically in table 11. To estimate the expected concentration of any constituent shown in table 11, multiply the specific conductance, measured in micromhos per centimeter at 25°C, by the number in the "Slope" column for the constituent of interest and add or subtract the number in the "Intercept" column for the same constituent. The result will be the estimated expected concentration of the constituent, in milligrams per liter.

For example, suppose a sample of water was collected from a well completed in valley-fill deposits and the specific conductance was found to be 380 micromhos. To estmate the expected hardness of the water, multiply 380 by 0.479 (the number in the "Slope" column of table 11 for hardness in water produced from the valley-fill deposits) and subtract 18.6 (the number in the "Intercept" column of table 11 for hardness in water produced from the valley-fill deposits). The estimated hardness is 163 mg/L. The actual water hardness of the sample may differ from this value somewhat. The amount that it might vary is related to the standard error of estimate shown in table 11.

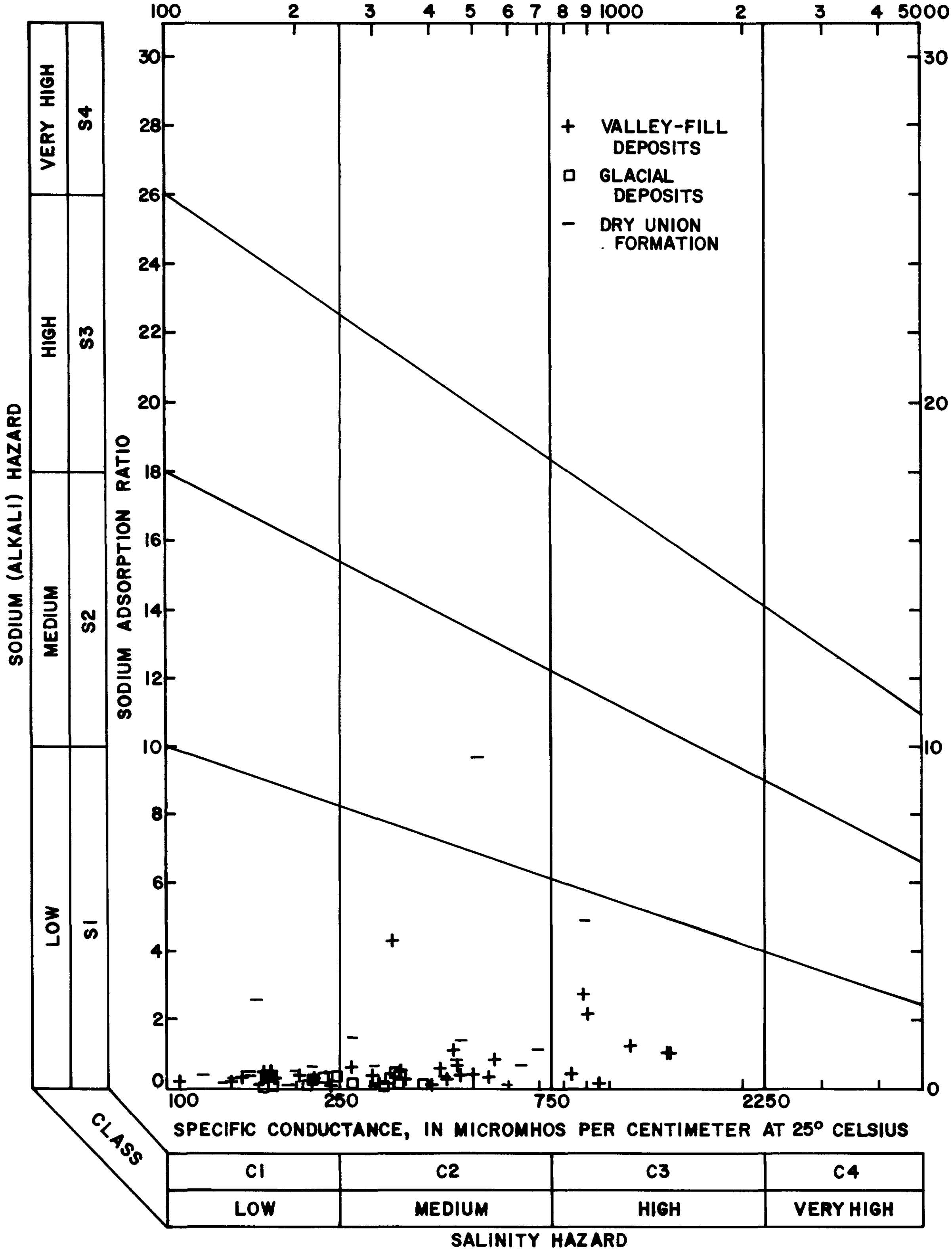

Figure 18. Classification of suitability of water from selected alluvial aquifers for irrigation use.

Table 10.--*Salinity and sodium classifications for irrigation water*

[Adapted from U.S. Salinity Laboratory Staff) 1954)]

SALINITY		
Class	Specific conductance, in micromhos per centimeter at 25° Celsius	Comments
C1 (low)--------	Less than 250	May be used for any crop on nearly all soils.
C2 (medium)-----	250-750	May be used if moderate leaching occurs.
C3 (high)-------	750-2,250	Should be used only on soils with better than adequate drainage and for plants with good salt tolerance.
C4 (very high)--	Greater than 2,250	Not suitable for irrigation under ordinary conditions, but may be used on permeable soil with adequate drainage if water is applied in excess to provide considerable leaching. Very salt-tolerant plants should be selected.

SODIUM	
Class	Comments
S1 (low)--------	May be used for any crop on nearly all soils.
S2 (medium)-----	May be used on coarse-textured (sandy) soils with good permeability; may present a moderate sodium problem in fine-textured (clay) soils unless gypsum is present.
S3 (high)-------	May present sodium problems in most soil types.
S4 (very high)--	Not suitable for irrigation of any crops in any soil, except under special conditions.
	Sodium-adsorption-ratio range for each class is dependent on specific conductance (see figs. 25-27).

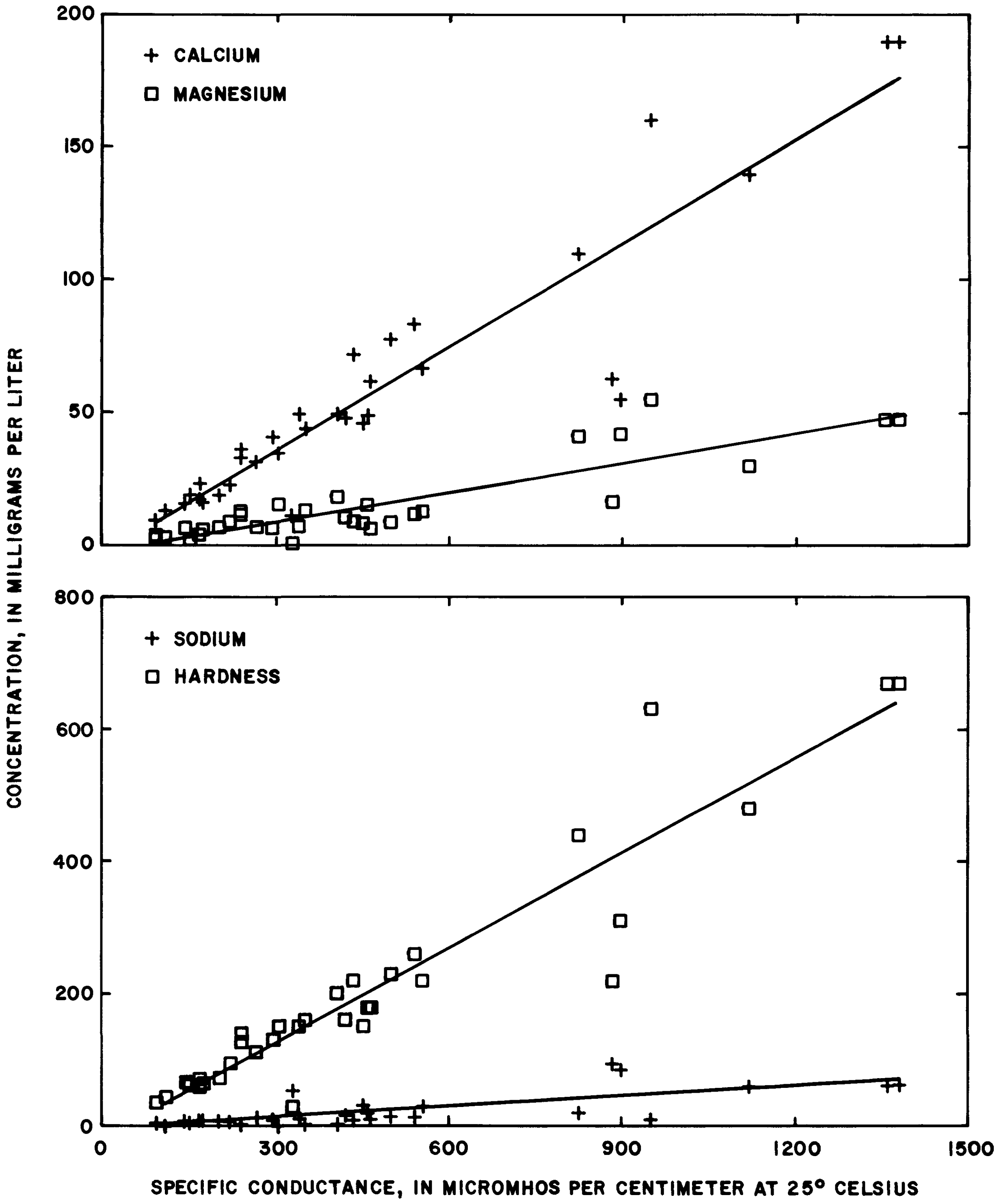

Figure 19.--Relationship of calcium, magnesium, sodium, and hardness to specific conductance in water produced from valley-fill deposits.

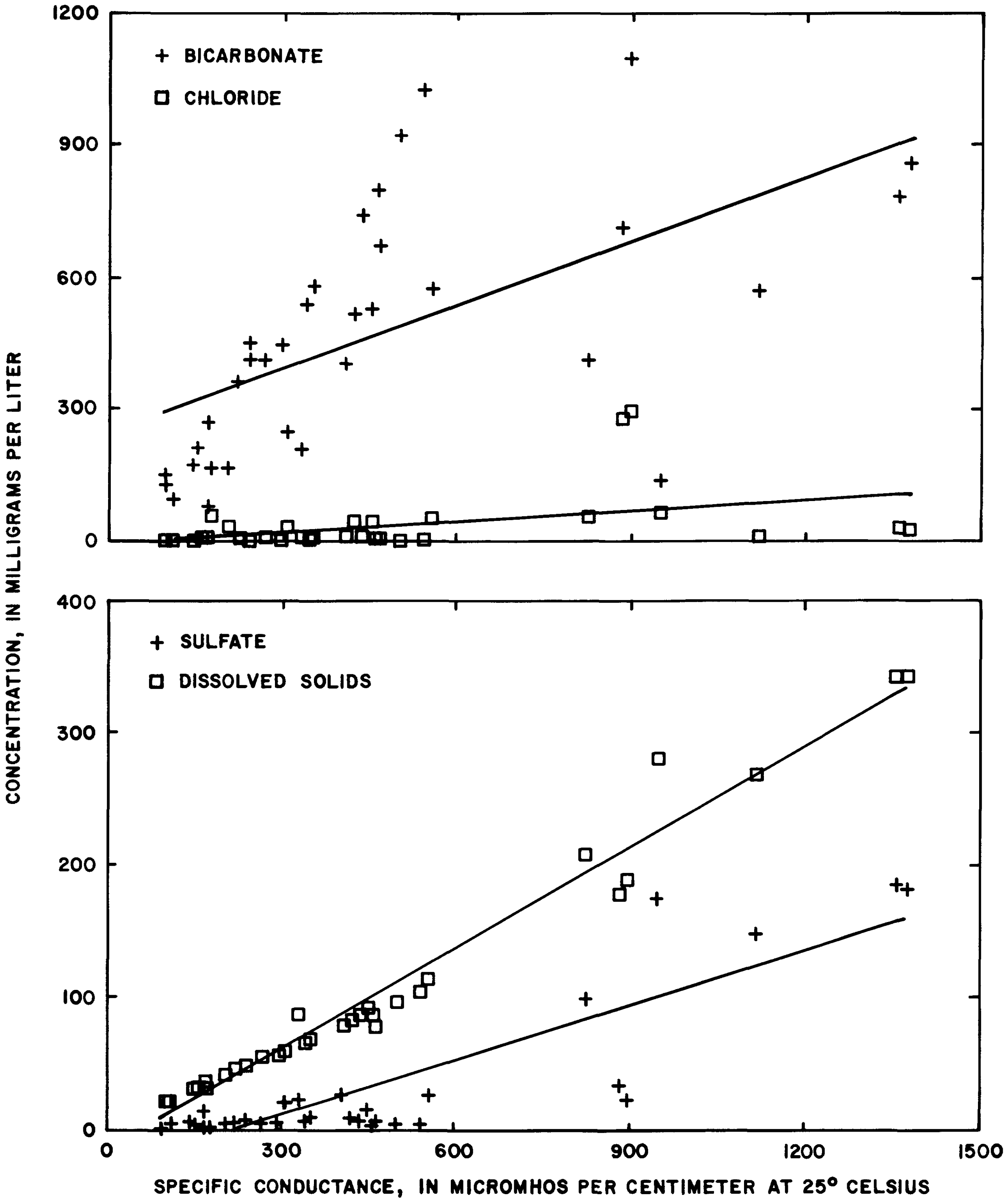

Figure 20.--Relationship of bicarbonate, chloride, sulfate, and dissolved solids to specific conductance in water produced from valley-fill deposits.

Table 11.--*Information for estimating concentrations of selected chemical constituents from specific conductance for water produced from selected deposits or formations*

[All regressions included are significant at the 95-percent confidence level and are based on the method of least squares]

Constituent to be estimated	Regression coefficients Slope	Regression coefficients Intercept	Correlation coefficient (R)	Standard error of estimate
		Valley-Fill Deposits		
Sodium	0.054	-4.13	0.76	16.6
Calcium	.130	-3.43	.93	17.6
Magnesium	.037	-2.44	.88	7.0
Hardness	.479	-18.6	.94	59.3
Bicarbonate	.162	81.7	.60	76.0
Chloride	.027	-1.25	.42	20.7
Sulfate	.414	-91.9	.87	83.3
Dissolved solids	.760	-43.2	.98	47.6
		Glacial Deposits		
Calcium	0.162	-5.05	0.96	3.9
Magnesium	.018	2.09	.72	1.6
Hardness	.484	-4.67	.98	9.1
Bicarbonate	.547	1.12	.93	19.3
Chloride	.015	-1.81	.63	1.7
Dissolved solids	.590	3.86	.99	5.4
		Dry Union Formation		
Sodium	0.104	-14.7	0.68	20.7
Calcium	.093	7.48	.82	12.0
Hardness	.280	32.7	.76	44.5
Bicarbonate	.274	61.0	.75	44.1
Chloride	.037	-6.89	.77	5.6
Sulfate	.210	-37.9	.82	26.6
Fluoride	.0014	.24	.45	.5
Dissolved solids	.637	-6.11	.99	16.8
		Dakota-Purgatoire Aquifer		
Sodium	0.171	-65.2	0.79	123.3
Calcium	.042	39.4	.51	65.5
Magnesium	.037	-8.44	.56	51.4
Hardness	.259	63.9	.57	347.0
Bicarbonate	.377	23.5	.79	270.3
Chloride	.047	-17.6	.67	48.4
Sulfate	.258	-66.2	.61	313.6
Fluoride	.00029	.45	.49	.5
Dissolved solids	.748	-81.6	.98	155.7

If the standard error of estimate is relatively large compared to the estimated value, the actual hardness value could be considerably different from the estimated value. Similarly, if the standard error of estimate is small compared to the estimated value, the actual hardness is likely to be quite similar to the estimated value. Making similar calculations based on the measured specific conductance of 380 micromhos would result in the following estimated concentrations for other water-quality constituents in water from this well: sodium, 16 mg/L; calcium, 46 mg/L; magnesium, 12 mg/L; bicarbonate, 143 mg/L; chloride, 9 mg/L; sulfate, 65 mg/L; and dissolved solids, 246 mg/L.

Glacial Deposits

The chemical quality of water produced from glacial deposits is quite similar, both for dissolved solids (fig. 16) and for other major dissolved constituents. This similarity reflects the similarity of the conditions which produce these waters: infiltrating water is of uniform quality, resulting primarily from snowmelt runoff; and the composition of the aquifer materials are similar from place to place.

All chemical analyses of water produced from the glacial deposits indicate the water is a calcium or calcium magnesium bicarbonate type, contains small dissolved-solids concentrations, and generally can be expected to meet the drinking-water criteria for all constituents (table 9). The water is suitable for irrigation (fig. 18, table 10), although water from some wells needs to be applied in sufficient quantities to allow moderate leaching of salts from the root zone.

Relationships have been developed to estimate expected concentrations of calcium, magnesium, hardness, bicarbonate, chloride, and dissolved solids based on specific conductance of water produced from glacial deposits (table 11). Use of these relationships is the same as described previously in the section on quality of water produced from valley-fill deposits.

Basin-Fill Deposits

Ground water is pumped from basin-fill deposits in three basins in the study area; from the Santa Fe Formation in the Wet Mountain Valley and from the Dry Union Formation in the Leadville and the Buena Vista-Salida ground-water basins. The quality of ground water produced from the Santa Fe Formation in the Wet Mountain Valley has been adequately discussed by Londquist and Livingston (1978). The discussion which follows considers only the quality of water produced from the Dry Union Formation in the Leadville and the Buena Vista-Salida ground-water basins.

The concentration of dissolved solids in water produced from the Dry Union Formation ranged from 65 to 597 mg/L with a mean value of 193 mg/L (fig. 16). The greatest dissolved-solids concentrations were in water from wells in the Leadville area of Lake County and in the Browns Canyon-Salida-Poncha Springs area of Chaffee County (fig. 21).

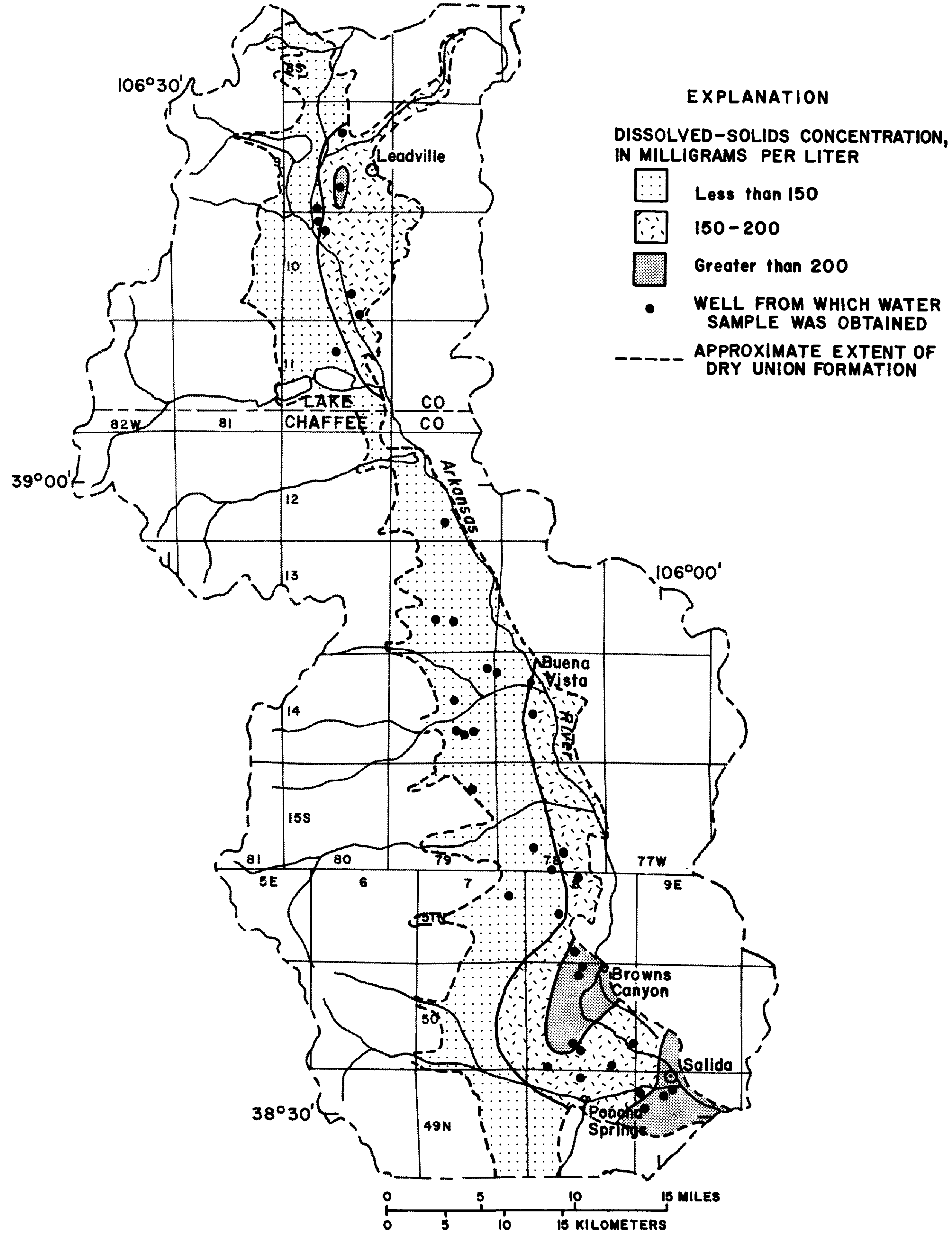

Figure 21.--Areal variation in concentration of dissolved solids in wate produced from the Dry Union Formation in Lake and Chaffee Counties.

Water from most wells sampled was of a calcium bicarbonate type. Water from several wells in the Leadville area and in the area between Salida and about 3 mi north of Browns Canyon, however, contained sodium as the dominant cation and sulfate as the dominant or codominant anion.

Water from the Dry Union Formation generally is suitable for use as a domestic or public supply (table 8). Large values of pH, and large concentrations of fluoride, hardness, and sodium can be expected to cause localized problems. Irrigation with water from the Dry Union Formation generally will not cause a salinity hazard if sufficient water is applied to cause moderate leaching when the specific conductance of the water exceeds 180 micromhos (fig. 18, table 10). A medium salinity hazard may exist when using water from wells in the Dry Union Formation which contain large concentrations of sodium. The hazard may be minimized by following the suggestions shown in table 10.

Relationships between specific conductance and sodium, calcium, hardness, bicarbonate, chloride, sulfate, fluoride, and dissolved solids have been developed for water from the Dry Union Formation. These relationships are listed in table 11.

Dakota-Purgatoire Aquifer

Water from this aquifer generally is produced from two separate geologic units: the Dakota Sandstone and the Lytle (=Cheyenne Sandstone) Sandstone Member of the Purgatoire Formation. As noted earlier in the section on Hydrologic Setting, the two formations are separated by a shale member, and many wells produce water from both sandstone units. The chemical quality of water from the two units generally is similar and will be discussed together.

The quality of water produced from the Dakota-Purgatoire aquifer shows the widest variations of any aquifer in the study area (fig. 16). The dissolved-solids concentrations of the water ranged from 126 to 3,960 mg/L, with a mean of 870 mg/L. The smallest concentrations occurred near the outcrop of the aquifer in the vicinity of Colorado City, Rye, Beulah, and Wetmore (pl. 8). Water type also varied greatly in the Dakota-Purgatoire aquifer, as shown in plate 8. Calcium bicarbonate water predominates in the outcrop areas west and southwest of Pueblo, while sodium bicarbonate water predominates in the outcrop areas northwest of Pueblo. Away from the outcrop areas, sulfate increases to become a dominant or codominant anion.

The suitability of water from the Dakota-Purgatoire aquifer for domestic or public supply for the constituents analyzed during this study is summarized in table 9. Water from this aquifer often exceeds the water-quality criteria shown in table 8 for sodium, hardness, sulfate, dissolved solids, iron, and manganese. In addition, the standard for nitrate was exceeded in four samples. All of these samples were collected in the area just east of Beulah. The large concentrations may therefore result from degradation by septic-tank effluent.

Of four ground-water samples analyzed for mercury from the Dakota-Purgatoire aquifer, only one contained this constituent at concentrations greater than the drinking-water standard; similarly, 4 of 10 samples analyzed for selenium had concentrations greater than the standard. These data indicate that it may be wise to analyze samples from this aquifer for these constituents if the water is intended for drinking. In addition to possible water-quality problems related to mercury and selenium, a recent report by Felmlee and Cadigan (1979) indicates that water samples collected from some wells completed in the Dakota-Purgatoire aquifer in the Beulah-Colorado City-Rye area contain concentrations of radium in excess of the standard of 5 picocuries per liter for drinking water (Colorado Department of Health, 1977, p. 28). Many of these wells also contain relatively large concentrations of uranium and radon.

Water from the Dakota-Purgatoire aquifer varies widely in its suitability for irrigation use (fig. 22). Water from many wells completed in this aquifer is not suitable for irrigation or is suitable only under special conditions (table 10). This situation indicates caution is necessary when using water from a well drilled in the Dakota-Purgatoire aquifer for irrigation without the benefit of an analysis for specific conductance and sodium-adsorption ratio. Relationships which can be used to predict concentrations of bicarbonate, calcium, chloride, dissolved solids, fluoride, hardness, magnesium, sodium, and sulfate for water produced from the Dakota-Purgatoire aquifer by using specific-conductance measurements have been developed and are listed in table 11.

Morrison Formation

Samples for chemical analysis were collected from seven wells completed in the Morrison Formation in southwestern Pueblo County. Concentrations of dissolved solids ranged from 476 mg/L to 1,830 mg/L with a mean value of 798 mg/L. Water type is variable and does not show a consistent areal trend. The dominant cation may be calcium or sodium, often with a relatively high percentage of magnesium. Bicarbonate or sulfate is the predominant anion.

In some areas, water produced from the Morrison Formation may not be suitable for domestic use because of large concentrations of dissolved solids, hardness, iron, manganese, sodium, sulfate, and zinc (table 9). Similarly, water produced from the Morrison Formation may not be suitable for irrigation because of a high salinity hazard and locally medium sodium hazard (fig. 22) unless special management practices are used (table 10).

Other Aquifers

Water-quality samples were collected and analyzed for chemical constituents from wells completed in several other deposits or formations in the study area. Because fewer than five water samples were collected from these deposits or formations (in most instances only one or two samples were collected), sufficient data were not available to make general statements concerning the quality of water produced. Chemical analyses of water from wells completed in the following deposits or formations are given in the Supplemental Information section (number of analyses shown in parentheses):

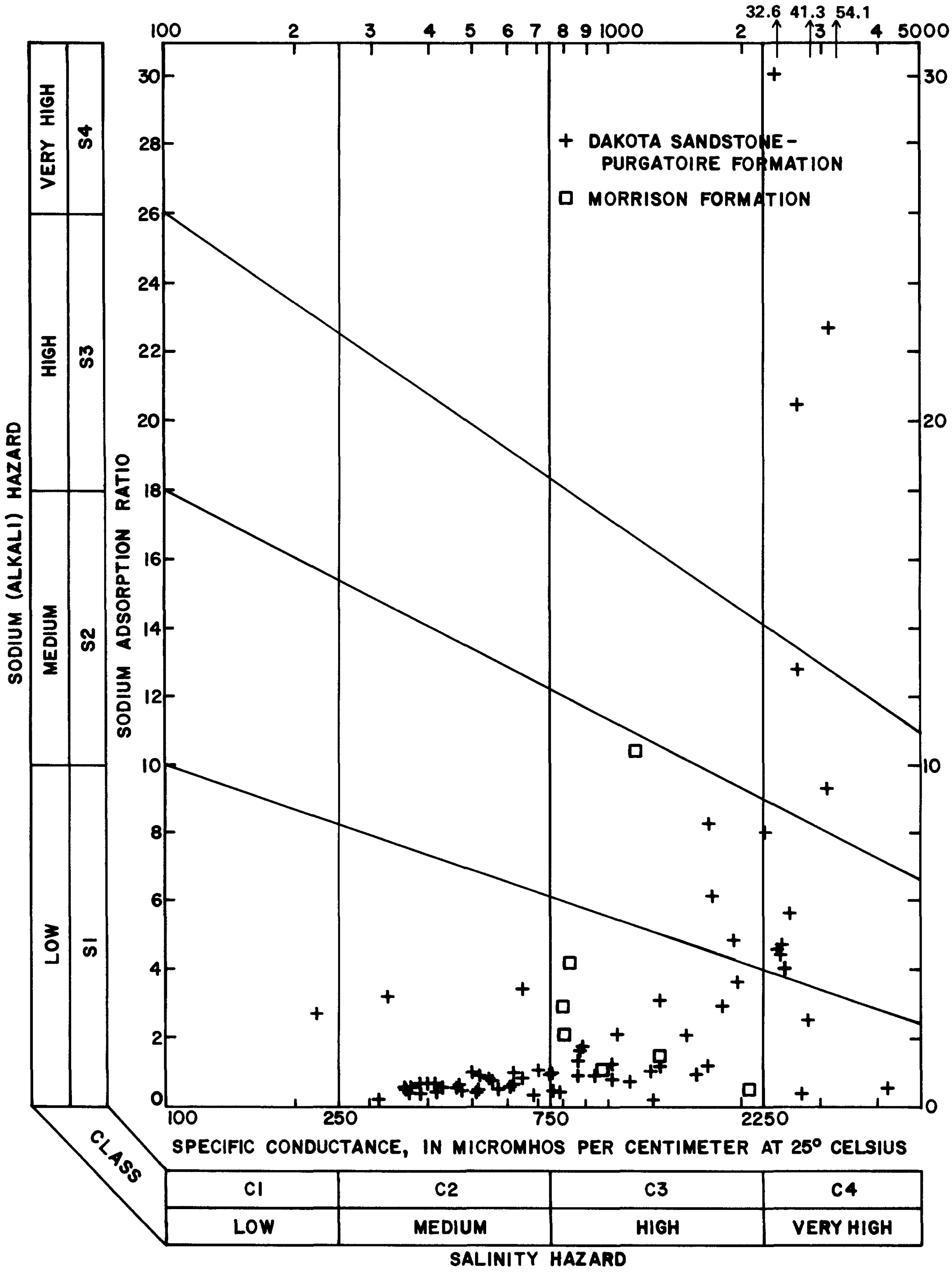

Figure 22.--Classification of suitability of water from the Dakota-Purgatoire aquifer and the Morrison Formation for irrigation use.

Flood-plain deposits (1); terrace deposits (2); Fort Hays Limestone Member of the Niobrara Formation (4); Codell Sandstone Member of the Carlile Shale (1); Bridge Creek Limestone Member of the Greenhorn Limestone (2); Entrada Sandstone (2); Fountain Formation (3); and Precambrian rocks (2).

Thermal Springs and Wells

Numerous springs and wells produce warm or hot water in the study area. Several of the larger thermal springs are shown in plate 6. A detailed investigation of the quality of water produced from these wells and springs was beyond the scope of this study. Reports by Barrett and Pearl (1976, 1978) include information on 19 thermal springs or wells in the study area.

Surface Water

The chemical quality of surface water in the upper Arkansas River basin is influenced by many factors, including ground water, direct runoff from snowmelt or rainfall, mine drainage, and water use within the basin. These factors result in distinct spatial and seasonal patterns of surface-water quality in the study area. The patterns are (1) Localized areas where stream quality is significantly influenced by mineralized drainage from mines; (2) a general downstream deterioration of water quality resulting from decreased precipitation and runoff, changes in geology and chemical composition of rocks, and increased water use; and (3) seasonal variations in surface-water quality resulting from varying degrees of dilution of more mineralized base flow by less mineralized runoff from snowmelt or rainfall.

The following evaluation of surface-water quality is based on data published annually by the U.S. Geological Survey since 1964 and reports by Wentz (1974), Moran and Wentz (1974), and Cain and Edelmann (1980).

Effect of Mine Drainage

Acid mine drainage as a term used to describe excessively mineralized and acidic water discharging from a mine. The chemical process that produces the acidic conditions begins with exposure of pyrite to oxidizing conditions which releases ferrous ions that subsequently oxidize and hydrolyze to produce insoluble ferric hydroxide (Moran and Wentz, 1974, p. 6). The resulting orange precipitate is characteristically found coating the bottoms of streams which receive acid mine drainage. In addition to the release of ferrous ions, the oxidation of pyrite also yields sulfuric acid which can decompose other minerals commonly associated with pyrite, such as sphalerite and galena. This decomposition produces cadmium, lead, and zinc, and possibly other toxic metals. Acid-mine drainage characteristically has a pH of 4.5 or less and contains excessive concentrations of iron, manganese, sulfate, and zinc, and occasionally excessive concentrations of cadmium, lead, and nickel. The mixing of acid mine drainage with streamflow results in decreased stream pH as the drainage is neutralized by bicarbonate; iron and copper also may precipitate as neutralization occurs. Zinc and manganese, however, tend to remain in solution until the pH is 7.0 or more (Moran and Wentz, 1974; Boyles and others, 1973).

Several mine-drainage tunnels and many draining mines are located in the study area, primarily in the Leadville, Climax, and Lake Creek areas of Lake and northern Chaffee Counties and in the Cripple Creek area of Teller County. The major mine-drainage tunnels in the study area are shown in plate 6. During a statewide evaluation of the effects of mine drainage on the quality of streams in Colorado, Wentz (1974, pl. 3) determined which streams in the study area were adversely affected by drainage from mines operated for production of metallic minerals (fig. 23). Areas near Leadville, Climax, and along Lake Creek in Lake County and Fourmile Creek in Teller County subsequently were studied in greater detail by Moran and Wentz (1974). Those studies indicated the primary source of degradation in the Arkansas River near Leadville is mine drainage from the Yak tunnel, which discharges to California Gulch. (Moran and Wentz, 1974, p. 41). This finding was substantiated by LaBounty and others (1975, p. 4).

The effects of mine drainage in the East Fork Arkansas River downstream from Climax were evident but were considered relatively minor by Moran and Wentz (1974, p. 73). The effects of mine drainage on the quality of streamflow in South Fork Lake Creek were not identifiable downstream from the confluence with North Fork Lake Creek (Moran and Wentz, 1974, p. 63). Because of a neutral pH (7.0) and small concentrations of most metals except manganese, the waters issuing from Carlton and Roosevelt tunnels near Cripple Creek do not significantly affect the quality of water in Cripple and Fourmile Creeks (Moran and Wentz, 1974, p. 77). Pine Gulch in Fremont County is included in figure 23 because the concentration of mercury in the water exceeded the limit identified as potentially harmful to aquatic life (Wentz, 1974).

Areal Changes in Surface-Water Quality

The chemical quality of surface water in the study area, as represented by specific conductance, generally is best in the mountainous areas (except those areas affected by mine drainage). The values for mean specific conductance at selected sites in the study area are shown in figure 24. Less specific conductance in the mountainous areas results from: (1) larger volumes of runoff resulting from greater precipitation (pl. 2), and (2) the predominance of chemically resistant metamorphic and igneous rocks (pl. 1). Water contacting these chemically resistant rocks will dissolve smaller quantities of the rocks resulting in less dissolved solids and less specific conductance in both the base flow and runoff. In the plains area east of Canon City, less precipitation results in less runoff to dilute base flow. Base flow in this part of the study area generally is greater in dissolved solids because ground water moves through aquifer materials that generally are more soluble and consist of limestones, sandstones, and shales (pl. 1).

The change in specific conductance in the main stem of the Arkansas River is shown in figure 25. Specific conductance decreases from Leadville to Granite as the effects of the mine drainage near Leadville are diluted by tributary inflows. The increase in specific conductance in the river from Granite to Pueblo results from a decrease in precipitation and runoff, from changes in geology, and from water use by agriculture and municipalities.

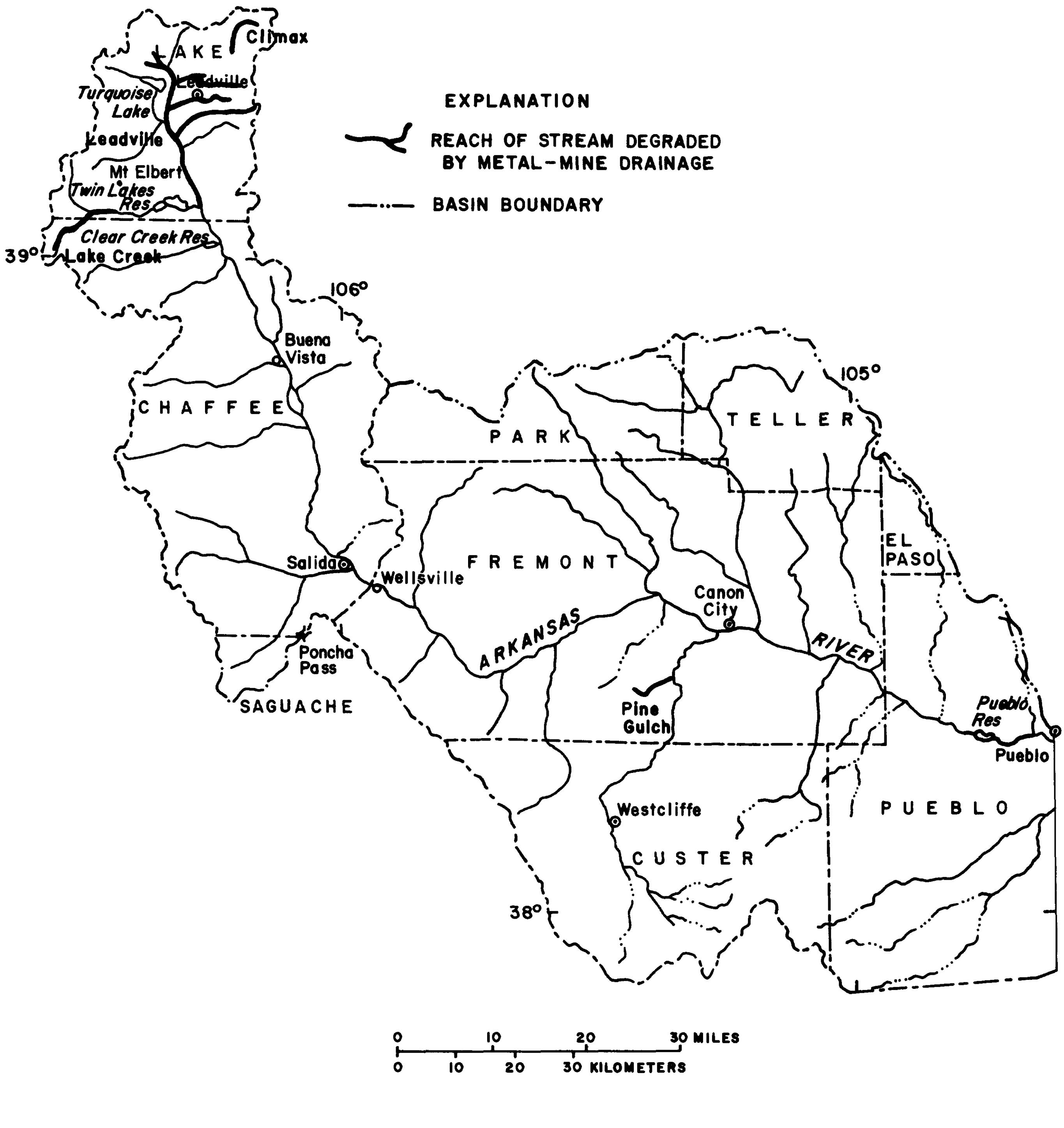

Figure 23.--Streams affected by metal-mine drainage (From Wentz, 1974, plate 3).

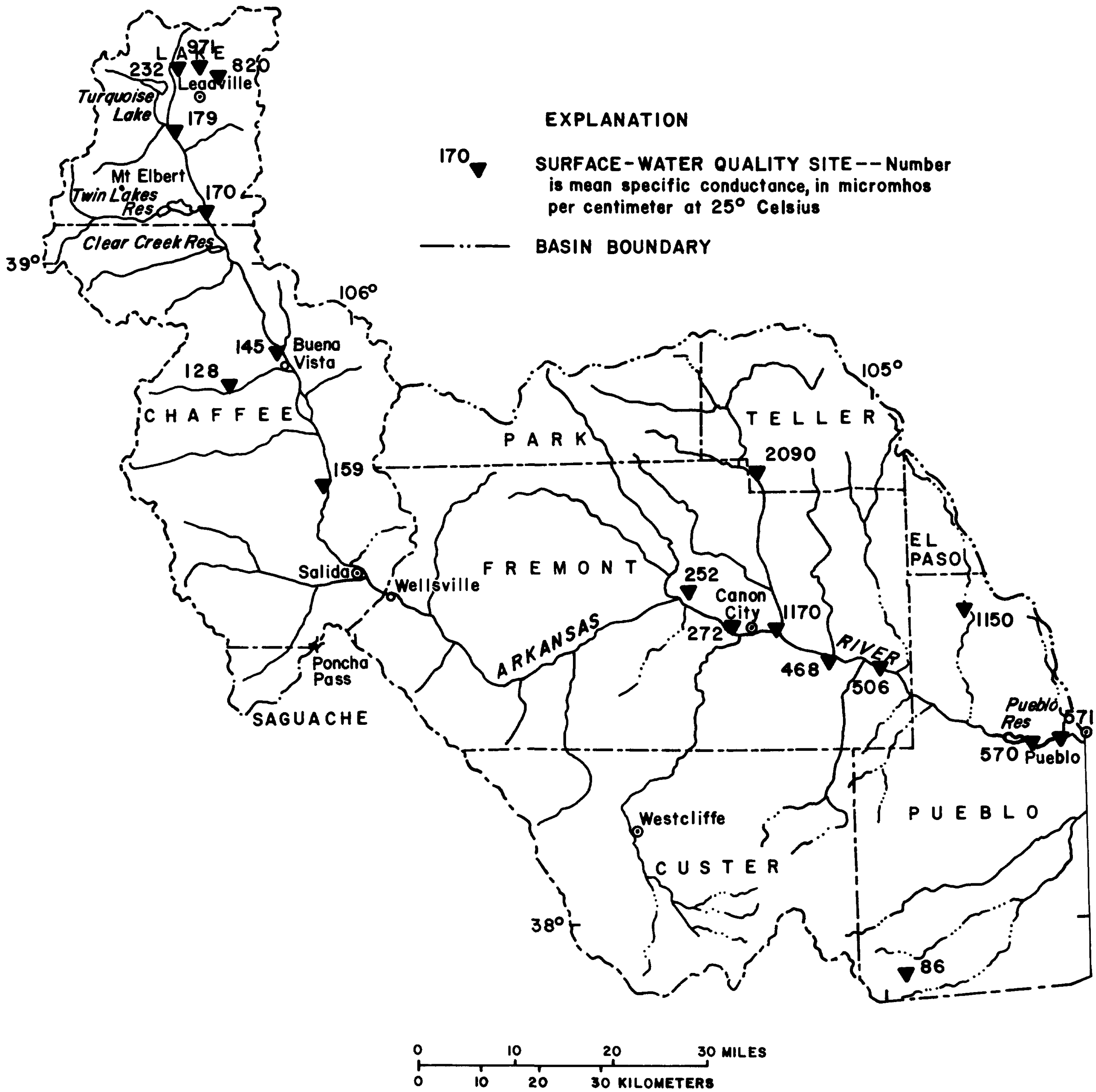

Figure 24.--Mean specific conductance of water at selected surface-water sites.

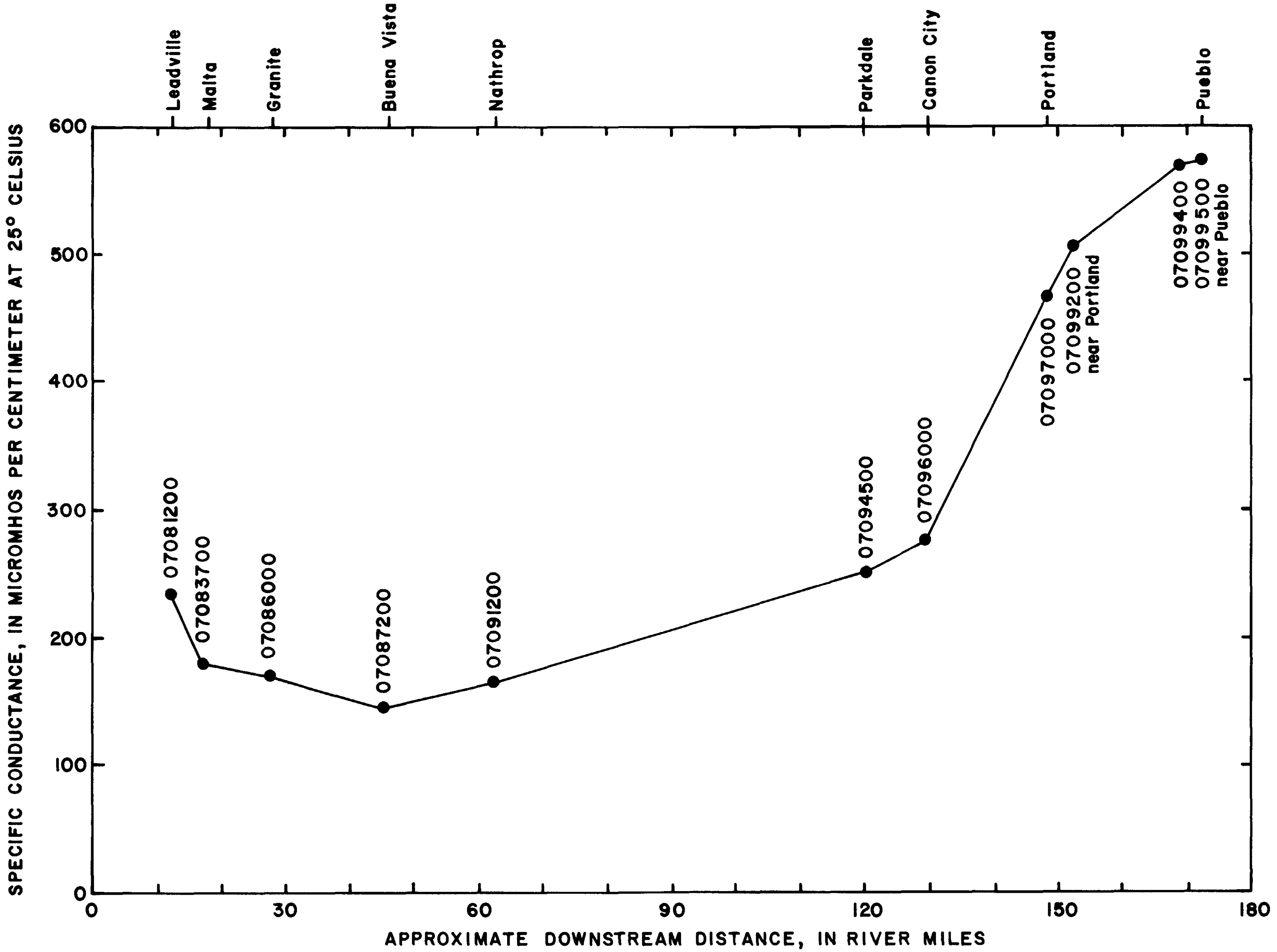

Figure 25.--Downstream changes in mean specific conductance in the Arkansas River.

Each time water is used and returned to the river, the dissolved-solids concentrations and specific conductance increase. In addition to this concentrating effect, information presented by Miles (1977, p. 30) indicates that a significant quantity of dissolved solids enters the river from geologic formations between Canon City and Portland.

In addition to a general downstream increase in specific conductance, there is also a change in water composition (fig. 26). In the vicinity of Leadville, water composition in the Arkansas River (sites 2 and 5, fig. 26) is significantly affected by mine drainage (sites 1 and 3, fig. 26), resulting in sulfate as the dominant or codominant anion. Between Malta (site 5) and Granite (site 6) tributary inflows containing little sulfate and excessive bicarbonate (similar in composition to water from site 4 on Halfmoon Creek) result in dilution of sulfate. This dilution of sulfate in the Arkansas River continues downstream to Canon City where sulfate constitutes only 20 percent of the total anions. Also, in the reach between Granite and Canon City the percentage of sodium plus potassium in the water increases by approximately one-half. From Canon City to Pueblo the percentage of sulfate more than doubles and the percentage of sodium continues to increase. These changes in composition may result from the inflow of water containing excessive dissolved solids from geologic formations discussed previously, and from the use of water for municipal and agricultural purposes.

Seasonal Changes in Surface-Water Quality

When direct runoff is not occurring as a result of snowmelt or rainfall, baseflow in the streams is maintained by ground-water inflows. In a typical year, this situation exists for most of the study area from October through March or April (figs. 6, 10, and 12). Ground water generally has greater dissolved solids and specific conductance than direct runoff in a given area because of the longer contact time of the water with the rocks of the area. This longer contact time results in more dissolution of minerals from the rocks. During low-flow or base-flow conditions, the specific conductance or concentration of dissolved solids generally is about maximum in the surface water of the study area. As the percentage of the streamflow from direct runoff increases, the specific conductance and dissolved solids generally decrease. The relationship of stream discharge to dissolved solids is shown in figure 27 for 07083000 Halfmoon Creek near Malta. Streamflow at this site is not affected by man, and a natural relationship exists between dissolved solids and stream discharge. Regulation of streamflow by reservoir storage and releases can greatly complicate this simple relationship. The relationship between specific conductance and discharge for the Arkansas River above Pueblo, just below Pueblo Reservoir (fig. 28), shows the complicating effects of streamflow regulation.

Suitability of Surface Water for Domestic or Municipal Supply

Water from the Arkansas River and its tributaries is used as a source of municipal supply for several cities in the study area, including Canon City and Pueblo. In the near future, water from the Arkansas River in Pueblo Reservoir will be delivered by pipeline to the Colorado Springs area for municipal use.

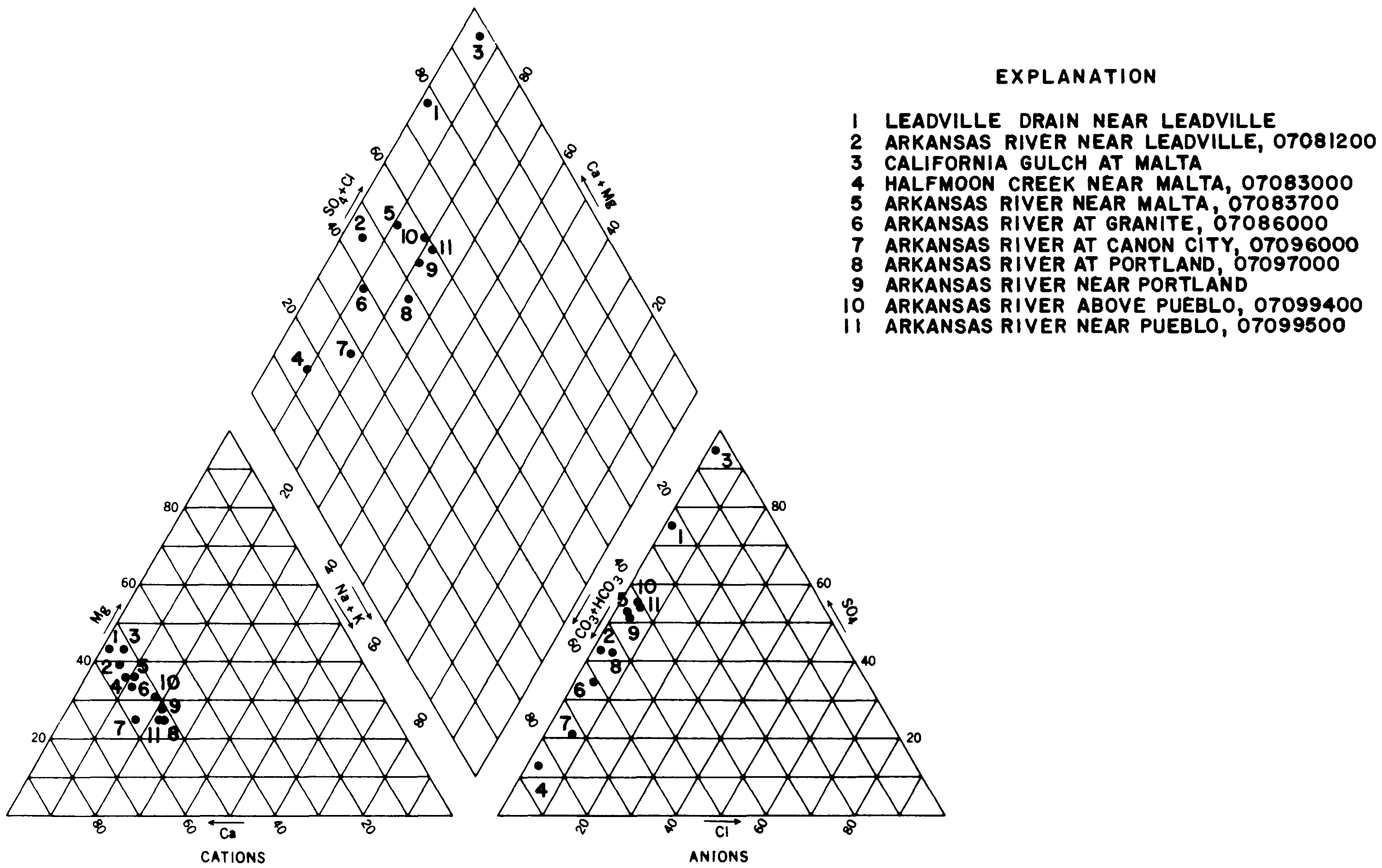

Figure 26.--Relative percentages of selected chemical constituents in water at selected surface-water sites, based on mean percentage of equivalent weights.

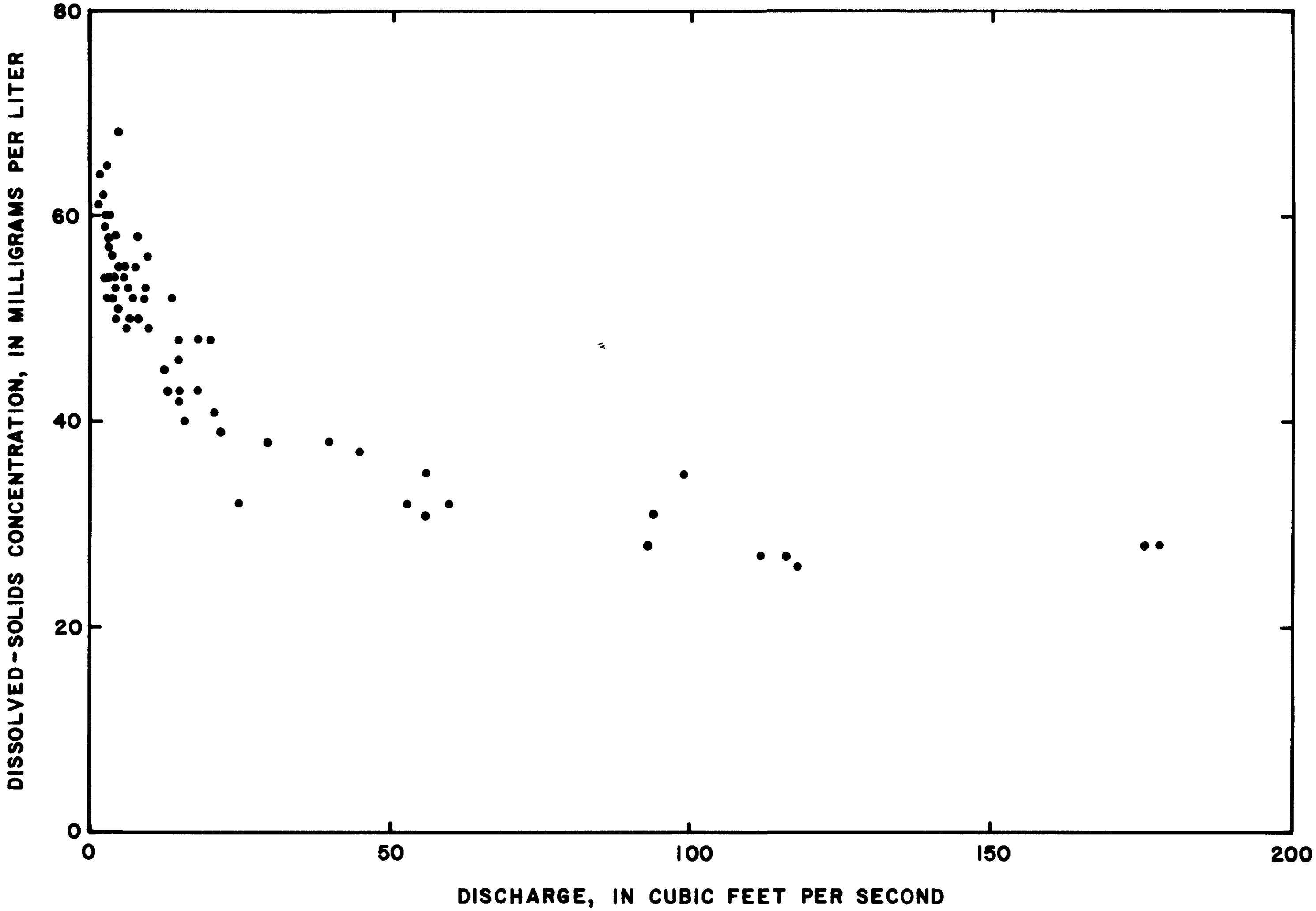

Figure 27.--Relation of discharge and dissolved solids at gage 07083000, Halfmoon Creek near Malta, water years 1975-80.

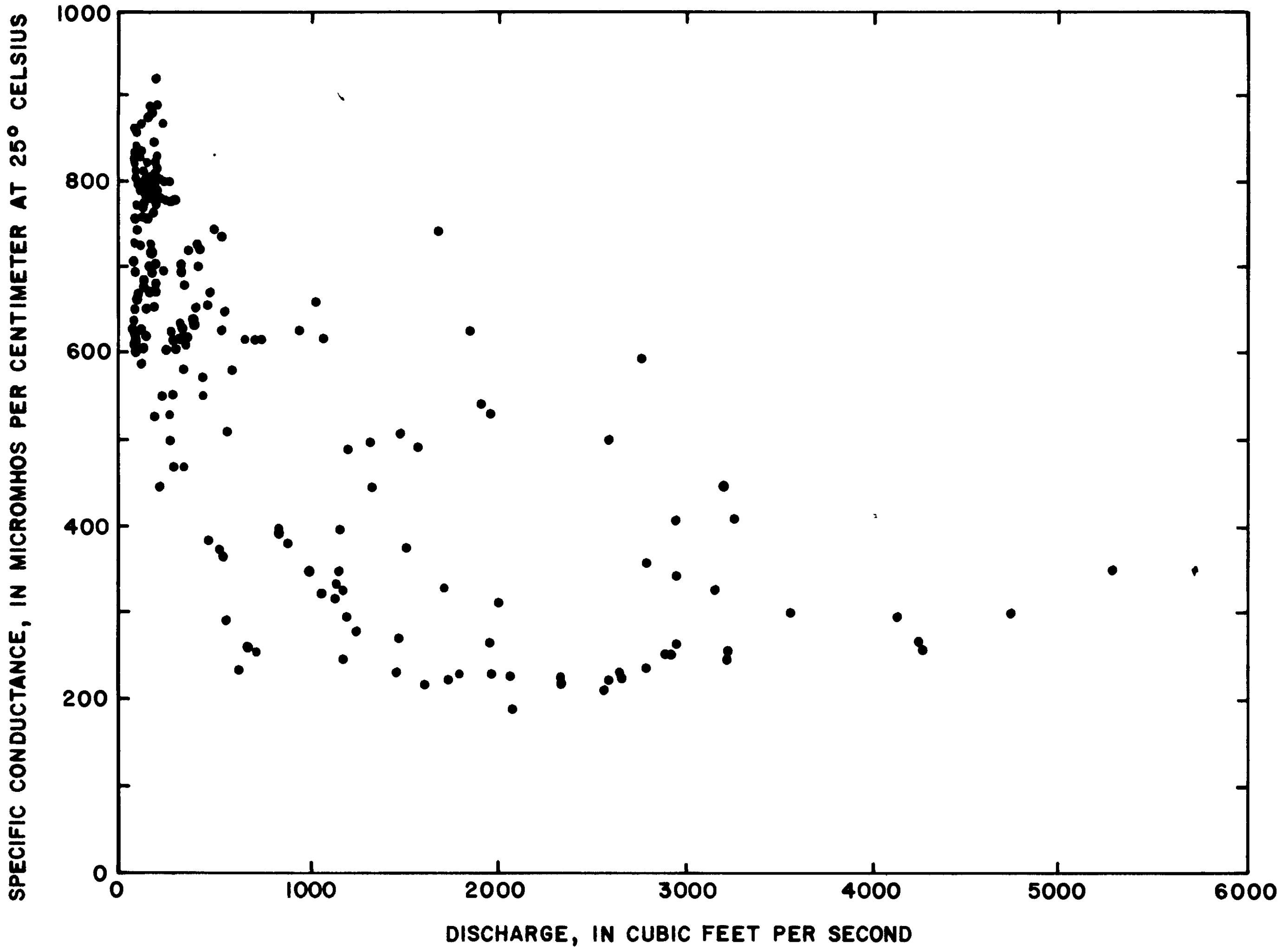

Figure 28.--Relation of mean daily discharge and daily specific conductance at gage 07099400, Arkansas River above Pueblo, 1978-80.

The following discussion of the suitability of surface water for domestic or municipal supply addresses only those chemical constituents that did not meet the water-quality criteria shown in table 8. Limited data for other water-quality constituents, including some trace metals, pesticides, and radiochemical constituents, are available for selected sites in the study area. A discussion of the additional data is, however, beyond the scope of this report.

Mine drainage in the Leadville area increases the concentrations of iron, manganese, and dissolved solids in the Arkansas River between Leadville and Malta. The resultant concentrations often exceed the water-quality criteria shown in table 8--especially during low flow. Values for pH also may be less than 6.5 during low flow. Water from the Arkansas River in this reach is likely to be hard to very hard during most of the year. Water quality improves downstream as a result of dilution of mine drainage by inflow of less mineralized water in the river between Malta and Granite. At Granite, problems with iron, manganese, and dissolved solids are not expected. The water in that area is, however, moderately hard to hard.

At Canon City, the only water-quality constituents which occasionally exceed the criteria for domestic or municipal supply (table 8) are manganese (which exceeded the criteria during low flow) and hardness. Water from the Arkansas River at Canon City is hard to very hard approximately one-half of the time.

At Portland, pH values of water from the Arkansas River occasionally exceeded the limit of 8.5 established for domestic or municipal supplies. Sodium concentrations in the water during low flow also may exceed the limit suggested for people on salt-restricted diets. Concentrations of dissolved solids, sulfate, and manganese may occasionally exceed criteria for domestic or public supply. Water from the Arkansas River at Portland is very hard about one-half the time. Problems associated with using water from the Arkansas River at Pueblo for domestic or municipal supply are similar to those encountered at Portland.

Suitability of Surface Water for Agriculture

Based on sodium-adsorption ratio and specific conductance, water from the Arkansas River throughout the study area generally is suitable for irrigation purposes (fig. 29). In the reach of the river from Canon City to Pueblo, a medium salinity hazard does exist (table 10) and water needs to be applied in sufficient quantities to allow moderate leaching. Water from the Arkansas River throughout the study area is suitable for stock watering, based on concentrations of dissolved solids (U.S. Environmental Protection Agency, 1976b, p. 208).

Estimation of Surface-Water Quality from Specific Conductance

Relationships which can be used to predict concentrations of major ions, hardness, dissolved solids, and, in some instances, silica, based on measurement of specific conductance have been developed by Gaydos (1980) for 10 surface-water sites in the study area. The relationships are similar to those in table 11 and are shown for the surface-water sites listed in table 12.

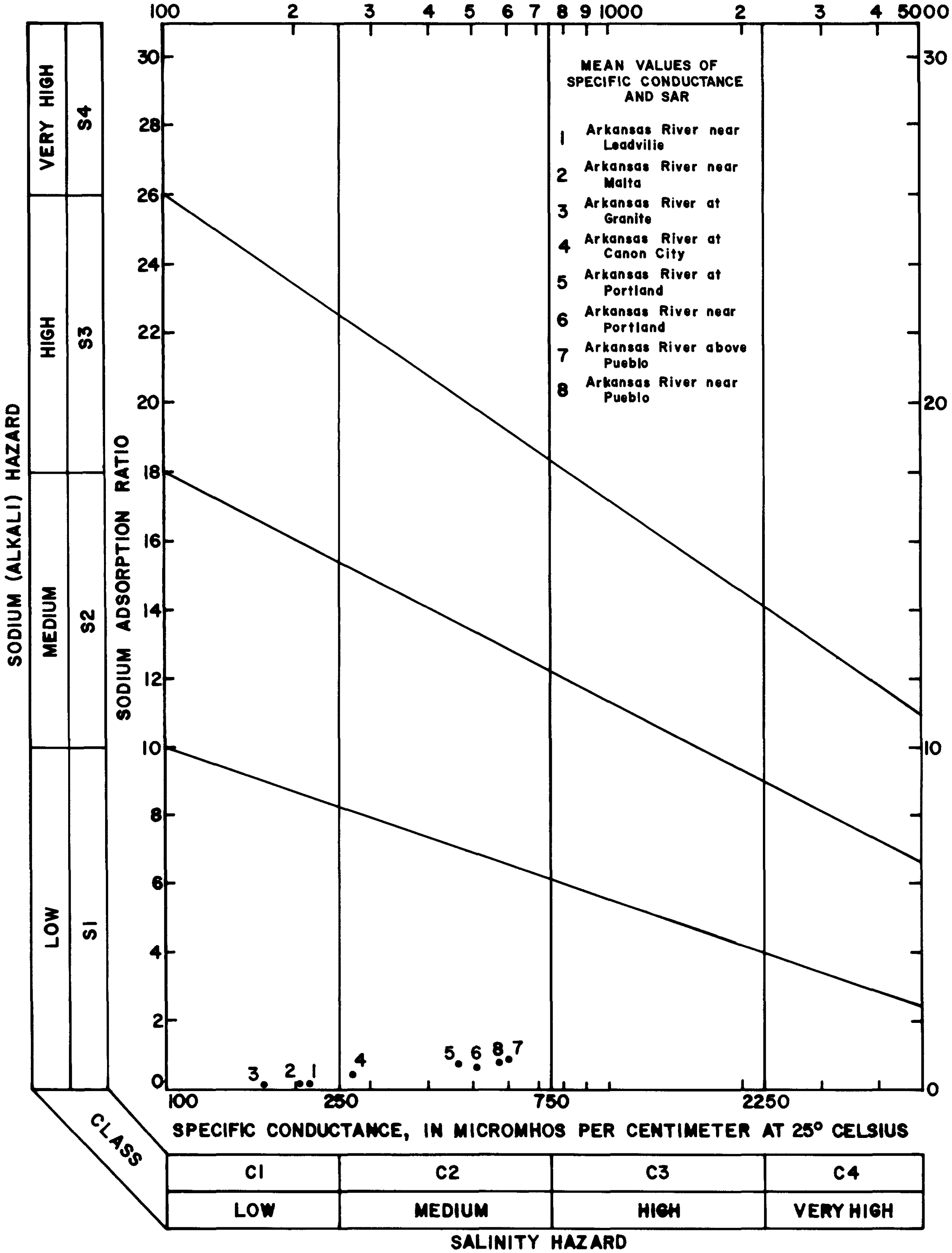

Figure 29.--Classification of suitability of water from the Arkansas River for irrigation use.

Table 12.--*Surface-water sites where equations used to estimate concentrations of selected chemical constituents from specific conductance have been developed by Gaydos (1980)*

Station No.	Station name
07079200	Leadville Drain at Leadville
07081200	Arkansas River near Leadville
07083000	Halfmoon Creek near Malta
07083700	Arkansas River near Malta
07086000	Arkansas River at Granite
07096000	Arkansas River at Canon City
07097000	Arkansas River at Portland
07099200	Arkansas River near Portland
07099400	Arkansas River above Pueblo
07099500	Arkansas River near Pueblo

SUMMARY

The upper Arkansas River basin of Colorado consists of the Leadville and the Buena Vista-Salida basins, the Wet Mountain Valley, and that part of the Great Plains known as the Canon City Embayment. This area relies mainly on surface water diverted from the Arkansas River and its tributaries for most of its water-supply requirements. Ground water is used mostly for limited domestic and municipal purposes and stock watering. During drought, direct diversions of surface water are substantially decreased to assure adequate water to satisfy senior water rights in the region east of Pueblo.

The annual streamflow of the Arkansas River has been increased during recent years with the development of the Fryingpan-Arkansas Project which diverts unappropriated water from the Colorado River drainage into the Arkansas River drainage through tunnels and ditches. Imports through the Charles H. Boustead Tunnel are expected to average 69,200 acre-ft per year during typical water years. Reservoir storage has been increased to serve peak water use during later summer months when agricultural demands are greatest and runoff from snowmelt and rainfall are minimal. Currently 26 streamflow gages and numerous evaporation and precipitation (rainfall and snow course) stations monitor potential and available runoff. Except for a short reach between Salida and Wellsville, seepage-loss measurements indicate the Arkansas River is gaining throughout most of the study area as a result of ground-water inflow.

Rocks in the upper Arkansas River basin range in age from Quaternary to Precambrian. Geophysical investigations indicate the thickness of alluvial sediments occupying the Leadville and the Buena Vista-Salida basins may be as much as 4,000 ft and 4,600 ft. Water in these sediments occurs under confined and unconfined conditions and well yields from aquifers in the valley-fill, glacial, and basin-fill deposits reportedly are as great as 1,000, 1,500, and 1,200 gal/min. Consolidated-rock aquifers consist primarily of sandstones. The most dependable and productive of these is the Dakota-Purgatoire aquifer with yields as much as 300 gal/min. Yields of flowing wells in this aquifer are estimated to range from a few gallons per minute to 150 gal/min. The volume of hydrologically recoverable water in storage in the upper 200 ft of unconsolidated saturated materials in the Leadville and the Buena Vista-Salida basins and Wet Mountain Valley is estimated to be 1.9, 3.8, and 4.5 million acre-ft.

The chemical quality of surface and ground water varies widely throughout the study area and was evaluated depending on its intended use. Generally surface water is acceptable for stock watering and irrigation but exceeds drinking-water criteria for hardness, iron, manganese, pH, and sulfate during low flow. The quality of the surface water deteriorates downstream to Pueblo Reservoir because of an increase in water use and a decrease in precipitation and ground-water inflow. Acid mine drainage was found to seriously degrade both surface- and ground-water quality in the Leadville area. Analyses of water from the Dakota-Purgatoire aquifer indicate that concentrations of dissolved solids, hardness, iron, manganese, radiochemical constituents, sodium, and sulfate generally exceeded drinking-water criteria.

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SUPPLEMENTAL INFORMATION

System of Numbering Wells

The well locations in this report are given numbers based on the U.S. Bureau of Land Management system of land subdivision, and show the position of the wells by quadrant, section, township, range, and position within the section. A graphic illustration of this method of well location is shown in figure 30. The first letter of the location number indicates which principal meridian governs the area in which the well is located; S indicates the sixth principal meridian and N indicates the New Mexico principal meridian. The second letter indicates the quadrant in which the well is located. Four quadrants are formed by the intersection of the base line and the principal meridian; A indicates the northeast quadrant, B the northwest, C the southwest, and D the southeast.

The first number indicates the township; the second, the range; and the third, the section in which the well is located. The letters following the section number indicate the location of the well within the section. The first letter denotes the quarter section; the second, the quarter-quarter section; and the third, the quarter-quarter-quarter section. The letters are assigned within the section in a counterclockwise direction, beginning with A in the northeast quarter. Letters are assigned within each quarter section and within each quarter-quarter section in the same manner. Where two or more locations are within the smallest subdivision, consecutive numbers, beginning with 1, are added in the order in which the wells are inventoried. For example, SC02106633DAA indicates a well in the NE¼NE¼SE¼ sec. 33, T. 21 S., R. 66 W.

System of Numbering Surface-Water Stations

Surface-water station numbers are assigned in downstream direction along the main stream. Station numbers on tributaries are assigned between station numbers on the main stream in the order in which those tributaries enter the main stream. Downstream-order station numbers are not assigned to miscellaneous sites where water-quality samples are collected or discharge measurements are made intermittently.

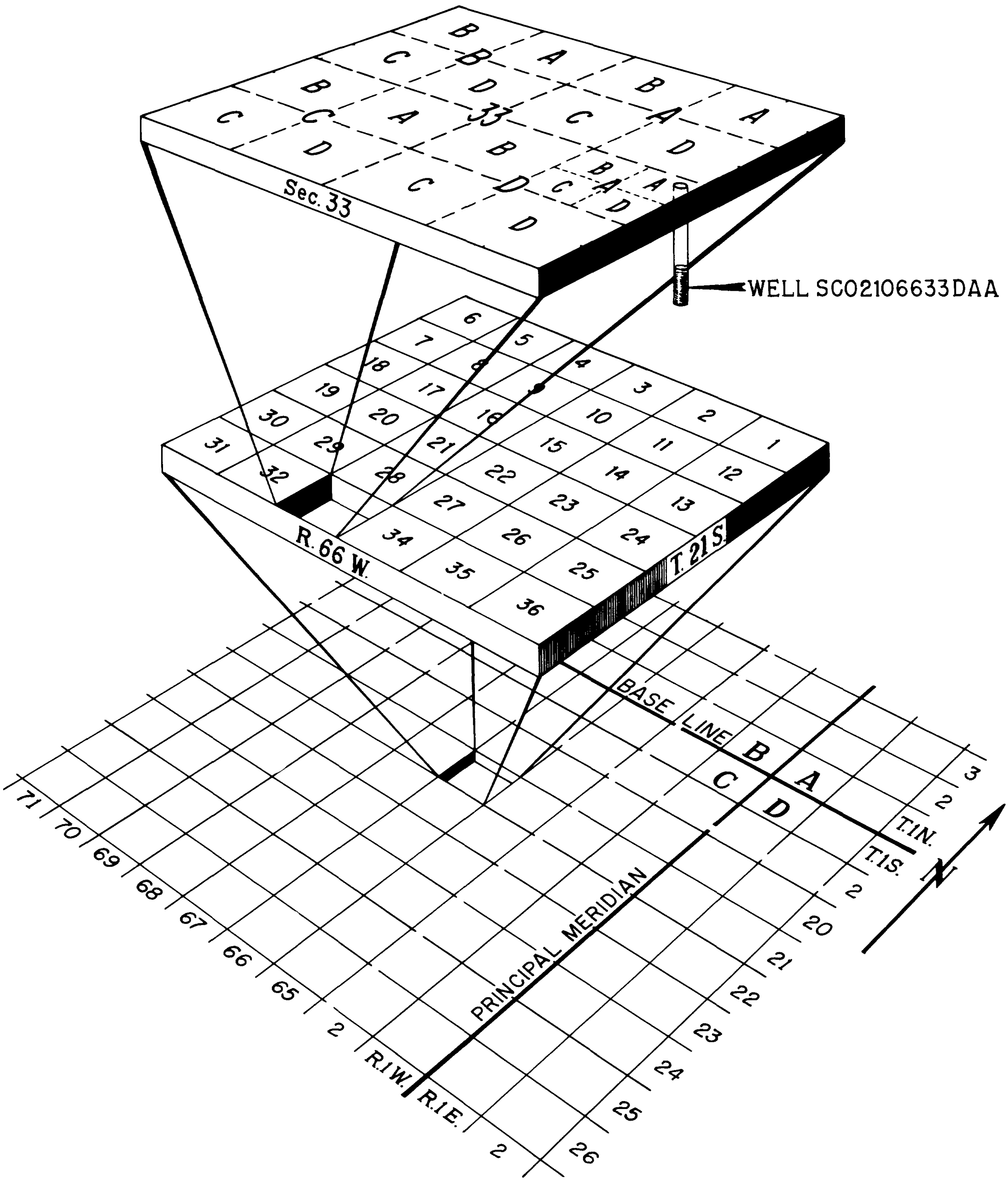

Figure 30.--System of numbering wells and springs in Colorado.

RECORDS OF SELECTED WELLS

EXPLANATION

WATER LEVEL: F, FLOWING.

MAJOR AQUIFER CODES:

111ALFP, ALLUVIAL FLOOD PLAIN DEPOSITS (VALLEY-FILL ALLUVIUM)
111VLFL, VALLEY-FILL DEPOSITS (VALLEY-FILL ALLUVIUM)
111AVMT, ALLUVIAL TERRACE DEPOSITS
112GLCL, GLACIAL DEPOSITS
112TERC, TERRACE DEPOSITS
112SNTF, SANTA FE FORMATION (BASIN-FILL AQUIFER)
121DRUN, DRY UNION FORMATION (BASIN-FILL AQUIFER)
120IRSV, TERTIARY INTRUSIVE ROCKS
120TRTR, TERTIARY SYSTEM, UNDIVIDED
120VLCC, TERTIARY VOLCANICS
211PIRR, PIERRE SHALE
211FRHS, FORT HAYS LIMESTONE MEMBER OF THE NIOBRARA FORMATION
211CDLL, CODELL SANDSTONE MEMBER OF THE CARLILE SHALE
211BGCK, BRIDGE CREEK LIMESTONE MEMBER OF THE GREENHORN LIMESTONE
211DKOT, DAKOTA-PURGATOIRE AQUIFER
217CYNN, LYTLE SANDSTONE MEMBER (EQUIVALENT TO CHEYENNE SANDSTONE) OF THE PURGATOIRE FORMATION (LOWER PART OF THE DAKOTA-PURGATOIRE AQUIFER)
221MRSN, MORRISON FORMATION
224ENRD, ENTRADA SANDSTONE
317FNTN, FOUNTAIN FORMATION
400PCMB, PRECAMBRIAN ROCKS

TYPE LIFT: B, BUCKET; C, CENTRIFUGAL; J, JET; P, PISTON; S, SUBMERSIBLE; T, TURBINE; U, UNKNOWN; Z, OTHER.

POWER: D, DIESEL; E, ELECTRIC; G, GASOLINE; H, HAND; L, LP GAS OR NATURAL GAS ENGINE; W, WINDMILL.

USE OF WATER: C, COMMERCIAL; F, FIRE; H, DOMESTIC; I, IRRIGATION; N, INDUSTRIAL; P, PUBLIC SUPPLY; R, RECREATION; S, STOCK; T, INSTITUTION; U, UNUSED; Z, OTHER.

RECORDS OF SELECTED WELLS

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM-ETER (IN)	TYPE LIFT	POWER	USE OF WATER
				CHAFFEE COUNTY							
NA04900701DBB	--	--	30	--	--	112GLCL	--	30	--	--	--
NA04900702DDB	1964	8020	44	9	11-71	100PCMB	85	16	--	--	U
NA04900801ACC	1963	7280	124	0	11-71	112GLCL	100	13	--	--	U
NA04900804ADA	1969	--	71	--	--	121DRUN	--	--	--	--	--
NA04900804BAA	--	7700	46	12	09-71	112GLCL	--	6	J	F	I
NA04900808ABB	1961	7675	37	3	11-71	111VLFL	130	30	--	--	U
NA04900810AAA	1955	7450	10	2	11-71	111VLFL	80	--	--	--	U
NA04900811BCA	1955	7300	40	3	11-71	111VLFL	900	--	--	--	H
NA04900905BBC	1915	7320	25	4	11-71	111VLFL	500	36	--	--	H
NA04900905DAD	1932	6851	125	--	--	121DRUN	--	6	S	E	P
NA04900906ACD	--	7085	30	4	11-71	111VLFL	--	--	J	E	U
NA04900907BDA	--	--	100	--	--	121DRUN	--	--	--	--	--
NA04900907CDA	--	--	--	--	--	121DRUN	--	--	--	--	--
NA04900908ABC	1967	--	60	--	--	121DRUN	14	4	--	--	--
NA04900910CDA	--	6950	45	--	--	111VLFL	--	4	--	--	C
NA05000734CCD	1955	--	27	--	--	111VLFL	5	6	--	--	--
NA05000736DDA	--	8080	85	30	09-71	111VLFL	--	6	--	--	I
NA05000802DAC	1964	7840	55	11	11-71	111VLFL	85	16	--	--	U
NA05000803BDA	--	7375	153	124	--	121DRUN	--	6	S	F	H
NA05000803BDC	1972	--	195	--	--	121DRUN	--	6	--	--	--
NA05000803DAD	1945	730	55	23	11-71	111VLFL	81	36	--	--	I
NA05000805BAD	1950	7920	151	5	11-71	111VLFL	450	--	T	E	U
NA05000810CCB	1965	7265	102	--	--	121DRUN	--	6	J	E	H
NA05000814DCB	--	7265	60	--	--	112GLCL	--	36	J	E	H
NA05000821AAC	1970	7280	246	141	05-72	121DRUN	--	6	Z	E	H
NA05000822DAB 1/	--	--	--	--	--	111VLFL	--	--	--	--	--
NA05000825BCC 1/	--	--	--	--	--	111VLFL	--	--	--	--	--
NA05000825DDB 1/	--	7140	--	--	--	--	--	--	--	--	U
NA05000826ABB	1954	7170	17	9	11-71	112GLCL	100	--	--	--	U
NA05000827ABD	1963	7260	213	55	11-71	112GLCL	1100	16	Z	D	I
NA05000828ABD	--	--	--	--	--	121DRUN	--	--	--	--	--
NA05000828DDD	--	--	--	--	--	121DRUN	--	--	--	--	--
NA05000832CAC	1973	--	200	--	--	121DRUN	--	6	--	--	--
NA05000832CDB	--	7850	--	5	11-72	111VLFL	--	36	--	--	U
NA05000833AAA	--	7980	25	--	--	111VLFL	--	36	J	E	H
NA05000835AAD	1954	7180	88	56	11-71	112GLCL	1500	--	T	D	I

1/ SPRING

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM-ETER (IN)	TYPE LIFT	POWER	USE OF WATER
CHAFFEE COUNTY -- CONTINUED											
NA05000835DCC	--	7460	--	28	04-73	121DRUN	--	6	S	E	P
NA05000930BCC	1974	--	51	5	--	121DRUN	--	--	--	--	--
NA05000931AAD	1916	7050	15	5	11-71	111VLFL	100	36	--	--	I
NA05000931BAB	--	7055	38	30	04-73	111VLFL	--	6	--	--	H
NA05000931CDC	--	--	--	--	--	111VLFL	--	--	--	--	--
NA05100713BCB	1974	--	87	23	--	121DRUN	--	--	--	--	--
NA05100808ABB	--	8075	78	15	11-71	112GLCL	525	16	T	--	I
NA05100809CDC	1963	7995	50	--	--	112GLCL	--	6	J	F	H
NA05100809DAB	--	--	50	--	--	121DRUN	--	--	--	--	--
NA05100816BBA	1962	7960	98	45	12-62	111VLFL	--	6	Z	E	C
NA05100821BCB	1962	--	126	--	--	121DRUN	--	--	--	--	--
NA05100833ADA	1962	7515	172	132	07-62	121DRUN	--	6	S	E	C
SC01107931CDA	--	8960	23	--	--	111VLFL	--	--	--	--	H
SC01207916CCC	1967	8800	53	--	--	111VLFL	--	--	J	E	C
SC01207934BBC	1973	--	110	--	--	121DRUN	--	--	--	--	--
SC01207934DBA	1960	8960	28	9	08-72	111VLFL	--	6	J	E	H
SC01307831BDB	1958	8210	106	93	05-72	112GLCL	--	7	S	E	S
SC01307831CAB	1957	8170	75	--	--	111VLFL	--	7	--	--	H
SC01307911ABC	--	8400	105	--	--	111ALFP	--	--	--	--	H
SC01307911ADB	1964	8290	70	--	--	112GLCL	10	6	--	--	H
SC01307914AAA	--	8330	--	40	05-72	111ALFP	--	6	J	E	H
SC01307915CDD	--	8840	300	98	05-72	121DRUN	--	6	--	--	H
SC01307922BAA	1971	8890	300	245	01-71	121DRUN	--	5	S	E	H
SC01307924CAD	1965	8150	54	27	11-65	111VLFL	20	7	--	--	C
SC01307927ACA	1974	--	355	--	--	121DRUN	--	--	--	--	--
SC01307928AAD	1973	--	120	--	--	121DRUN	--	5	--	--	--
SC01307933DAB	--	8960	110	31	05-72	112GLCL	--	8	S	E	C
SC01307935BCA	--	8519	--	99	05-72	111VLFL	--	--	S	E	S
SC01407805BAD	1971	8040	70	53	10-71	112GLCL	--	7	S	E	H
SC01407805CBB	--	8000	65	--	--	112GLCL	--	--	--	--	H
SC01407807BBB	1969	--	145	--	--	121DRUN	--	--	--	--	--
SC01407818BCC	1971	8110	39	14	09-71	111VLFL	--	6	S	E	H
SC01407821BCB	1967	--	64	--	--	121DRUN	8	--	--	--	--
SC01407822ADD	--	7960	140	88	05-72	400PCMB	--	--	S	E	C
SC01407822BCA	--	7850	60	--	--	111VLFL	--	--	--	--	H
SC01407827BCB	1969	7850	40	20	12-69	111ALFP	15	7	J	E	H

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM-ETER (IN)	TYPE LIFT	POWER	USE OF WATER
			CHAFFEE	COUNTY -- CONTINUED							
SC01407828DDC	1961	7770	80	3	05-72	111VLFL	--	--	J	E	H
SC01407830DAA	1971	8086	1000	26	10-71	112GLCL	--	6	--	--	U
SC01407831AAA	1930	8091	28	20	10-71	111VLFL	--	40	--	--	U
SC01407832ABA	--	8010	38	7	05-72	111ALFP	--	36	J	E	H
SC01407834DBA	--	7780	85	--	--	111VLFL	--	6	--	--	S
SC01407901DBB	1974	--	165	132	--	121DRUN	--	--	--	--	--
SC01407912BDD	1970	8200	85	--	--	111ALFP	--	--	S	E	H
SC01407913ACA	1960	8095	53	2	11-71	111ALFP	250	14	--	--	P
SC01407913ADB	1959	8090	72	6	08-59	111VLFL	--	8	T	E	P
SC01407914ADD	1967	8230	25	12	05-67	111VLFL	--	--	J	F	H
SC01407914CBB	--	8390	145	--	--	121DRUN	--	--	S	F	H
SC01407921DDA 1/	--	8580	--	--	--	120IPSV	--	--	--	--	--
SC01407922DCB	1969	8390	50	13	05-72	111VLFL	--	5	S	F	H
SC01407924BBC	--	8240	58	--	--	111VLFL	--	7	J	E	C
SC01407925BCB	--	--	40	12	--	121DRUN	--	--	--	--	--
SC01407926LBB	1972	--	100	--	--	121DPUN	--	--	--	--	--
SC01407926BDB	1972	--	190	--	--	121DRUN	25	--	--	--	--
SC01407928AAA	1968	8590	100	74	05-72	121DPUN	--	--	S	E	H
SC01407929ACA	1972	8910	69	--	--	111VLFL	--	--	--	--	H
SC01507813CBA	1968	7695	62	35	05-72	111VLFL	--	6	S	E	C
SC01507819BCA2 1/	--	8150	--	--	--	120IRSV	--	--	--	--	U
SC01507823DAB	--	--	25	--	--	111VLFL	--	24	--	--	--
SC01507826BAB1	--	7760	30	--	--	111VLFL	--	6	J	E	H
SC01507826BAB2	--	7762	30	2	05-72	111VLFL	--	--	--	--	--
SC01507826BCB 1/	--	--	--	--	--	111VLFL	--	--	--	--	--
SC01507826BDB	1973	--	25	--	--	111VLFL	--	96	--	--	--
SC01507828CCA	--	--	--	--	--	121DPUN	--	--	--	--	--
SC01507831DCC	1961	8560	61	--	--	112GLCL	--	--	--	--	H
SC01507832AAB	--	8560	61	--	--	111VLFL	--	--	J	--	H
SC01507834AAC	--	--	65	--	--	121DRUN	--	--	--	--	--
SC01507834CCD	--	--	31	--	--	121DPUN	--	6	--	--	--
SC01507911DDA	--	9120	143	--	--	121DRUN	--	--	S	E	P
SC01507924ACC	--	8250	40	34	10-65	121DPUN	--	--	S	E	--
SC01507924BDA 1/	--	8300	--	--	--	120IRSV	--	--	--	--	R
SC01507924BDD	--	8225	172	--	--	111VLFL	--	6	S	E	H
SC01507927CAC	1964	8473	50	18	05-72	111VLFL	--	7	S	E	H
SC01507927CAD	1962	8380	50	8	04-62	111VLFL	--	6	J	E	H
SC01507928DAA	1969	7920	85	--	--	111VLFL	--	--	--	--	P

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			CUSTER	COUNTY							
NA04501202DAA	—	8835	110	—	—	112TERC	—	6	S	E	H
NA04601203DDD	1954	7650	150	F	10-70	112SNTF	—	5	T	G	I
NA04601210BDD	—	7860	—	143	05-74	111ALFP	—	6	P	W	S
NA04601210DCB	—	7880	145	133	05-74	111ALFP	—	6	P	W	S
NA04601211ACC	—	7620	130	51	10-70	112SNTF	—	—	T	—	I
NA04601211CDA	—	7749	196	24	10-70	112SNTF	—	6	P	W	S
NA04601212DAC	—	7620	104	F	10-70	112SNTF	20	8	—	—	I
NA04601212DBB1	—	7630	161	D	11-70	112SNTF	—	8	—	—	H
NA04601212DBB2	—	7640	159	F	10-70	112SNTF	—	8	—	—	H
NA04601212DBC	—	7650	184	F	10-70	112SNTF	40	8	—	—	I
NA04601212DBD1	—	7600	89	F	10-70	112SNTF	40	10	—	—	I
NA04601212DBD2	—	7615	121	F	10-70	112SNTF	9	10	—	—	I
NA04601212DDB	—	7625	131	F	10-70	112SNTF	18	10	—	—	I
NA04601213ACB	—	7740	53	8	04-71	112GLCL	—	6	S	E	H
NA04601214BBD	—	7879	108	24	10-70	112SNTF	—	—	P	W	S
NA04601215AAC	—	7910	163	23	10-70	111ALFP	—	6	P	W	S
NA04601215ABC	—	7935	—	86	05-74	111ALFP	—	6	P	W	S
NA04601222DDA	—	8330	60	35	05-74	111ALFP	—	6	—	—	H
NA04601227ADB	—	8465	70	63	05-74	111ALFP	—	6	—	—	H
SC02106903DDB	—	6070	35	21	07-71	111ALFP	—	36	S	E	S
SC02106909DCA	1972	6570	592	67	10-72	211DKOT	225	10	—	—	U
SC02106910DDC	1908	6240	20	15	08-71	111ALFP	—	40	J	E	H
SC02106914CCC	1969	6480	700	41	02-69	211DKOT	500	8	T	F	I
SC02106915ACA	1903	—	18	15	01-03	112TERC	12	36	J	—	H
SC02106926BCC	—	6480	362	F	06-71	317FNTN	12	6	—	—	I
SC02106933AAA	1964	6770	320	45	10-70	211DKOT	50	10	S	F	I
SC02107018DDB	1972	8360	73	40	04-72	400PCMB	2	6	S	E	J
SC02107225ACB	—	8070	50	27	11-70	112GLCL	—	8	P	W	S
SC02107302DDD	—	7713	62	19	10-70	112SNTF	—	—	P	W	S
SC02107308BDD	1971	7615	66	—	—	120VLCC	—	5	J	F	H
SC02107318DBC	—	7960	183	87	05-71	112GLCL	—	6	P	G	S
SC02107321CDC	1955	7820	120	9	10-70	112SNTF	350	8	T	E	I
SC02107321CDD	—	7880	174	52	10-70	112SNTF	350	—	T	E	I
SC02107324BCB	—	7882	30	26	10-70	120VLCC	—	—	P	W	S
SC02107326CCC	—	7841	25	12	04-71	112SNTF	—	12	P	W	S

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			CUSTER COUNTY — CONTINUED								
SC02107327CBC	--	7862	110	24	08-72	112TERC	--	6	P	W	--
SC02107327CDC	1953	7891	62	17	10-70	112SNTF	--	8	T	I	I
SC02107327DCC	--	7880	70	19	10-70	112SNTF	--	8	T	L	I
SC02107327DDD	1953	7850	30	7	10-70	112SNTF	--	--	T	F	H
SC02107328BDC	--	7928	117	72	10-70	112SNTF	--	6	P	W	S
SC02107328DAA	--	7896	110	19	10-70	112SNTF	--	7	P	W	S
SC02107334AAA	--	7840	202	F	10-70	112SNTF	--	12	--	--	I
SC02107334BAA	1947	7878	128	9	10-70	112SNTF	--	12	T	D	I
SC02107334BBB	1947	7890	220	14	10-70	112SNTF	1203	12	T	--	I
SC02107334BBC	1974	7885	92	16	05-75	111ALFP	--	3	--	--	U
SC02107334DBB	1947	7868	202	F	10-70	112SNTF	--	24	--	--	I
SC02107334DBD	--	7859	284	F	10-70	112SNTF	--	12	--	--	I
SC02107335CCB	1947	7821	197	F	10-70	112SNTF	--	8	--	--	I
SC02107335CDB	1946	7805	124	F	10-70	112SNTF	60	--	--	--	I
SC02207101DAD	1960	9060	85	55	04-60	111ALFP	10	5	J	E	H
SC02207102CAC	--	9080	38	28	08-71	400PCMB	--	4	P	G	S
SC02207106AAC1	1963	8200	41	8	11-70	120VLCC	--	6	J	F	S
SC02207106AAC2	--	8220	40	14	11-70	120VLCC	--	10	S	E	H
SC02207107AAC	--	8410	71	13	11-70	112SNTF	--	7	P	W	S
SC02207107BCA	1959	8340	30	9	08-71	120VLCC	--	6	J	F	H
SC02207109DCB	--	7940	31	25	08-71	111ALFP	--	36	J	E	H
SC02207110BAD	1966	9000	89	20	11-70	400PCMB	--	6	S	E	H
SC02207207CCA	--	7775	11	8	07-71	112GLCL	--	30	C	E	H
SC02207211CCB	--	8123	74	36	08-71	400PCMB	--	6	P	W	S
SC02207214BCD	--	8195	43	25	08-71	400PCMB	--	6	P	W	S
SC02207214CDA	--	8260	50	35	11-70	112SNTF	--	6	P	W	S
SC02207216BDD	--	7980	119	5	11-70	120VLCC	--	--	T	E	P
SC02207217CAC1	1920	7890	120	69	10-70	120TRTR	300	8	T	E	P
SC02207217CAC2	--	7890	120	--	--	120TRTR	350	8	T	E	P
SC02207217CAC3	1920	7890	120	--	--	120TRTR	300	8	T	H	P
SC02207222DAD	1916	8210	38	28	11-70	112SNTF	--	60	P	W	S
SC02207229ADD	--	7972	130	93	11-70	112SNTF	--	--	P	W	S
SC02207229BCB	--	7850	19	14	12-70	112GLCL	--	36	J	F	H
SC02207229CCA	--	7870	13	4	11-70	112GLCL	--	40	P	F	S
SC02207230BBC	1966	7856	81	5	08-71	112SNTF	--	7	S	F	H

RECORDS OF SELECTED WELLS--Continued

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM-ETER (IN)	TYPE LIFT	POWER	USE OF WATER
			CUSTER	COUNTY -- CONTINUED							
SC02207231DDA	--	7905	10	7	11-70	112GLCL	--	48	--	--	S
SC02207232AAB	1960	7954	89	62	10-70	112SNTF	--	--	P	W	S
SC02207232DDA	1960	7955	60	52	10-70	112SNTF	--	--	P	W	S
SC02207306ACB	--	8430	46	15	10-70	112GLCL	--	6	S	E	H
SC02207308DCA	--	8301	75	8	10-70	112GLCL	--	6	P	W	S
SC02207309AAC	--	8032	49	3	11-70	112TERC	--	8	P	W	S
SC02207310ACC	--	7915	70	3	11-70	112TERC	--	12	--	--	I
SC02207310ACD	--	7908	160	8	11-70	112TERC	--	--	S	E	H
SC02207311CDD	1947	7850	93	9	10-70	112TERC	--	6	J	E	S
SC02207312BCA	1946	7785	350	9	11-70	112SNTF	--	--	J	E	H
SC02207312BDB	--	--	35	--	--	112GLCL	--	--	--	--	S
SC02207312CBA	--	7800	50	5	11-70	112TERC	--	6	C	E	H
SC02207312CDC	--	7790	63	1	11-70	112TERC	--	12	--	--	I
SC02207312DDC	--	7778	45	5	11-70	112GLCL	--	12	--	--	I
SC02207313CDC	--	7830	94	5	04-71	112GLCL	--	7	S	E	S
SC02207314BDD	1946	7870	100	8	10-70	112TERC	--	6	J	E	H
SC02207315BCB	1963	8060	95	9	10-70	112TERC	5	6	P	W	S
SC02207321BDC	--	8240	72	6	11-70	112TERC	--	6	C	E	H
SC02207321DAB	--	8120	99	6	11-70	112TERC	--	--	J	E	H
SC02207323ACB	1959	7883	39	4	10-70	111VLFL	--	6	J	E	H
SC02207323ACC	1963	7900	403	3	11-70	112SNTF	--	16	T	--	I
SC02207323BBC	1963	7920	217	1	10-71	112TERC	--	16	--	--	I
SC02207325ABD	--	7880	14	2	10-70	112TERC	--	40	J	--	H
SC02207325BDD	--	7910	65	0	10-70	112TERC	--	10	P	W	S
SC02207326ABB	--	7940	50	2	11-70	112TERC	--	6	P	E	S
SC02207326BBA	1934	7990	74	3	11-70	112TERC	--	6	J	--	S
SC02207326BCC	--	8015	141	F	11-70	112TERC	--	12	--	--	S
SC02207327BAD	1964	8040	128	12	12-64	112TERC	--	7	--	--	H
SC02207328BBC	1953	8238	89	--	--	112TERC	--	6	C	E	H
SC02207328BDD	--	8243	82	12	08-71	112TERC	--	8	J	E	H
SC02207331ADB	--	7895	15	9	11-70	112GLCL	--	36	J	E	S
SC02207335CDB	--	8182	13	4	04-71	112TERC	--	18	J	E	H
SC02207336DAA	--	7990	26	4	11-70	112SNTF	--	6	P	--	S
SC02207336DCC	--	8050	156	3	11-70	112SNTF	--	12	--	--	I
SC02307104DCC	1861	8635	18	5	04-71	111ALFP	--	60	--	--	S

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			CUSTER	COUNTY — CONTINUED							
SC02307109ABC	1971	8650	110	70	04-71	400PCMB	2	6	—	—	H
SC02307109DBB	—	8660	300	71	04-71	400PCMB	—	6	—	—	H
SC02307201AAB	1953	8400	13	9	04-71	111VLFL	—	48	P	W	S
SC02307204CDB	1958	7975	30	3	11-70	111ALFP	—	7	J	E	H
SC02307205ABB1	1870	7905	16	13	11-70	111ALFP	—	—	P	E	H
SC02307205ABB2	—	7895	12	4	11-70	111ALFP	—	60	—	—	S
SC02307206AAB1	1971	7930	1170	-11	10-71	112SNTF	—	1	—	—	U
SC02307206BDD	—	7995	34	1	11-70	111ALFP	—	6	P	W	S
SC02307206CBD	—	8043	40	4	11-70	111ALFP	—	6	P	—	S
SC02307207ADA1	—	8000	16	4	11-70	111ALFP	—	60	P	H	S
SC02307207ADA2	—	7995	25	3	11-70	111ALFP	—	8	P	E	S
SC02307207BCC10	—	8133	180	13	10-70	112SNTF	—	12	T	E	I
SC02307207BCC2	—	8132	22	3	08-71	111ALFP	—	6	—	—	U
SC02307207CBB1	—	8142	28	1	10-70	111ALFP	—	12	—	—	U
SC02307207CBB2	—	8142	115	1	10-70	111ALFP	—	12	—	—	—
SC02307207CCC1	—	8180	120	1	10-70	112SNTF	—	—	T	E	I
SC02307207CCC2	—	8175	30	1	11-70	111ALFP	—	8	—	—	U
SC02307208CCC	1962	8035	60	3	11-70	112SNTF	—	6	P	—	S
SC02307210BBA	1960	8070	115	85	12-70	112SNTF	—	6	P	—	S
SC02307210BDD	1952	8000	44	12	12-70	111ALFP	—	8	J	E	H
SC02307210DDD	—	8020	54	10	10-70	112SNTF	—	—	T	E	I
SC02307213ACC	—	8300	7	2	11-70	112GLCL	—	36	P	H	H
SC02307214BBD	—	8060	52	44	12-70	111ALFP	—	40	P	E	S
SC02307214CAA	—	8055	35	9	12-70	111ALFP	—	6	—	—	H
SC02307215BBB	—	8005	45	7	11-70	111ALFP	—	8	J	E	H
SC02307216ABA	—	7995	30	3	11-70	111VLFL	—	6	C	E	H
SC02307216CAC	—	8025	66	2	11-70	112SNTF	—	8	C	E	H
SC02307217BBC	1963	8050	245	32	10-70	112SNTF	—	16	T	E	I
SC02307218AAD	1974	8059	75	9	05-74	111ALFP	—	2	—	—	U
SC02307218ABB	—	8082	22	3	10-70	112GLCL	—	—	—	—	S
SC02307219ADD	—	8165	28	9	11-70	111ALFP	—	6	P	W	S
SC02307219BCC	1961	8375	83	11	11-70	112SNTF	15	6	P	W	S
SC02307220BBC	—	8154	13	6	11-70	111ALFP	—	36	C	E	S
SC02307220CBC1	—	8200	23	2	11-70	112GLCL	—	—	C	G	S
SC02307220CBC2	—	8200	76	4	11-70	112GLCL	—	10	—	—	S

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			CUSTER	COUNTY -- CONTINUED							
SC02307220CBC3	1947	8198	900	11	07-71	112SNTF	--	8	--	--	U
SC02307221ACB	--	8078	65	5	11-70	111ALFP	50	6	S	E	H
SC02307221DCC	1951	8105	40	6	11-70	111ALFP	--	8	S	E	H
SC02307222BAC	1960	8061	51	12	11-70	112SNTF	--	8	--	--	--
SC02307223BCB	--	8073	50	4	12-70	111ALFP	--	6	P	W	S
SC02307223DDD	1940	8125	180	0	11-70	112SNTF	--	--	T	--	S
SC02307224ABB	1960	8215	100	63	12-70	112SNTF	--	6	P	W	S
SC02307224CCC	--	8130	23	15	11-70	111ALFP	--	36	J	E	S
SC02307224CDB	--	8135	160	5	11-70	112SNTF	--	6	--	--	S
SC02307224DBC	--	8181	96	38	11-70	112GLCL	--	6	S	E	H
SC02307224DDA	1960	8185	82	25	11-70	112GLCL	--	6	P	W	S
SC02307226CBB	--	8151	60	21	09-70	112GLCL	--	6	P	W	S
SC02307233DAA1	--	8200	16	3	11-70	111ALFP	--	48	J	E	H
SC02307233DAA2	1964	8215	100	2	11-70	112SNTF	15	6	S	E	S
SC02307236ADB	--	8182	100	1	11-70	112SNTF	--	12	T	G	I
SC02307304CAC	1970	8600	95	22	04-71	112GLCL	10	6	S	E	H
SC02307315AAB	1966	8806	52	22	08-71	112GLCL	--	--	J	E	H
SC02307315ACD	--	8895	113	67	09-70	112GLCL	--	--	S	E	H
SC02307315ADB	--	8865	70	68	09-70	112SNTF	--	4	S	E	H
SC02307323ADC	1970	8760	57	34	08-71	112TERC	14	6	S	E	H
SC02307324ABB	--	8405	8	2	11-70	112TERC	--	--	--	--	H
SC02407104CAD	--	8455	220	187	12-70	111ALFP	--	--	P	W	--
SC02407105BCA	--	8320	197	89	12-70	112SNTF	--	--	P	W	S
SC02407106BAA	--	8240	29	25	04-71	121DRUN	--	36	P	W	S
SC02407107ACD	--	8358	142	138	04-71	112SNTF	--	6	P	W	S
SC02407114DCA	1965	8721	70	24	10-70	112SNTF	10	5	P	W	S
SC02407115BCC	--	8480	228	219	04-71	112SNTF	--	--	P	W	S
SC02407117ABA	--	8438	--	208	08-71	112SNTF	--	6	P	W	S
SC02407117CBA	--	8485	--	258	04-71	112SNTF	--	6	P	W	S
SC02407118DAA	--	8465	240	--	--	112SNTF	--	6	P	W	S
SC02407119BDD	1931	8571	332	320	04-71	112SNTF	--	5	--	--	H
SC02407122BBC	--	8585	--	309	04-71	112SNTF	--	6	P	--	S
SC02407125CBA	1966	9038	400	165	06-66	112SNTF	--	5	P	W	S
SC02407135BAB	--	8875	--	--	--	112TERC	--	--	P	W	S
SC02407204DBB	1964	8320	142	4	11-70	111ALFP	20	6	C	E	S
SC02407205ABB	1964	8545	150	92	11-70	112SNTF	--	6	P	G	S
SC02407215AAD	1959	8495	310	295	12-59	112TERC	5	6	P	W	S
SC02407228CAA	--	8170	12	5	11-70	112TERC	--	36	C	E	H

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTITUDE OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAMETER (IN)	TYPE LIFT	POWER	USE OF WATER
FREMONT COUNTY											
NA04801107AAD	1968	7060	86	50	05-72	--	--	--	J	E	H
NA04801120BBC	--	6540	--	--	--	111ALFP	--	--	--	--	--
NA04801129ACC	1969	6520	44	20	04-73	111VLFL	--	6	S	E	H
NA04801223BAB1	--	6300	52	27	05-72	111ALFP	--	--	J	E	C
NA04801223BAB2	--	6305	20	--	--	111ALFP	--	--	--	--	Z
NA04801231BBD	--	6380	60	9	09-78	111VLFL	--	6	J	E	H
NA04901019CAA	--	6820	70	--	--	--	--	--	--	--	H
NA04901034ABA	1969	6725	44	32	08-69	--	12	6	--	--	H
SC01607033CDC	--	6281	130	227	09-72	--	--	8	--	--	U
SC01707004ACB	1964	6226	342	98	09-72	317FNTN	5	6	S	F	T
SC01707004DCC	--	6175	64	35	09-72	--	--	--	--	--	H
SC01707016CCC	1945	5960	12	12	11-71	317FNTN	200	10	--	--	U
SC01707016DDC	1906	6020	672	F	12-72	317FNTN	--	14	--	--	I
SC01707032CCC	1952	6180	60	20	11-71	111ALFP	60	--	--	--	I
SC01707034CCD	--	5670	--	F	04-72	317FNTN	1125	--	--	--	P
SC01707130CCC	1968	6800	628	F	04-72	211DKOT	--	12	--	--	I
SC01707226BDD	1932	6230	80	30	11-71	211DKOT	--	--	--	--	H
SC01806817BAA	--	5695	228	--	--	217CYNN	--	6	P	W	S
SC01806833DAC	1972	5390	65	45	04-73	211FRHS	--	6	S	E	S
SC01806923DCA	--	5498	172	35	07-62	--	--	6	P	W	S
SC01806926CBB	1905	5525	1240	F	02-74	211DKOT	360	--	--	--	S
SC01807026BBA	1905	5400	1670	F	04-72	211DKOT	--	8	--	--	I
SC01807027CCD	--	5315	32	2	07-62	111ALFP	--	3	--	--	U
SC01807032CCA	1908	5350	30	7	11-71	111ALFP	2	--	T	E	Z
SC01807032CCB	1937	5351	26	7	11-71	111ALFP	--	13	--	--	N
SC01807033CBA	--	5310	9	6	11-71	111ALFP	--	--	--	--	U
SC01807036CBD	--	5285	34	--	--	--	--	6	J	F	Z
SC01807109DAA	1966	6350	93	--	--	211DKOT	--	8	S	E	H
SC01807110DAA	--	6395	--	--	--	111ALFP	--	--	J	F	C
SC01807118BAD	--	5725	9	--	--	111ALFP	--	--	--	--	C

RECORDS OF SELECTED WELLS--Continued

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI-TUDE-OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM-ETER (IN)	TYPE LIFT	POWER	USE OF WATER
FREMONT COUNTY -- CONTINUED											
SC01807118BBB	--	5750	65	49	04-73	--	--	6	--	--	H
SC01807131BBB	--	6220	200	70	01-56	211DKOT	--	--	--	--	S
SC01906804ABC	--	5378	137	47	03-73	211FRHS	--	6	S	E	I
SC01906804CAA	1966	5335	58	52	03-73	211FRHS	25	6	S	E	H
SC01906805CBA	--	5325	148	--	--	211FRHS	--	6	S	E	Z
SC01906806CDA	--	5330	33	14	07-62	--	--	10	--	--	U
SC01906807BAC	1931	5245	733	F	12-75	211DKOT	140	5	--	--	U
SC01906807CCA	1941	5180	--	F	12-71	211DKOT	--	8	--	--	I
SC01906812BCC	1937	5320	540	9	01-73	211DKOT	--	8	--	--	S
SC01906813CDD	--	5200	524	--	--	211DKOT	--	5	--	--	H
SC01906814CAD	1966	5160	99	48	01-73	211FRHS	2	6	--	--	U
SC01906817CBC	--	5040	25	19	07-62	111ALFP	--	46	C	E	I
SC01906818CBC	--	5080	20	--	--	111ALFP	65	24	T	E	N
SC01906818CDB	--	5065	12	--	--	211FRHS	75	--	C	--	I
SC01906820AAA	1916	5030	615	F	08-33	211DKOT	300	4	--	--	U
SC01906821BDB	--	5040	10	3	07-62	--	--	36	--	--	U
SC01906823BAB	1953	5420	658	F	12-71	211DKOT	37	8	--	--	U
SC01906823DCD	--	5104	27	16	07-62	111ALFP	--	4	--	--	U
SC01906830BCA	1966	5208	1096	F	12-71	211DKOT	76	7	--	--	N
SC01906901DAB	--	5241	1800	F	--	211DKOT	--	--	--	--	U
SC01906901DCD	1925	5235	1875	F	12-71	211DKOT	300	10	--	--	H
SC01906907CCC	--	5340	120	60	--	--	--	6	J	E	H
SC01906907CDA	1961	5190	8	6	07-62	111ALFP	--	20	J	E	I
SC01906913ABB	--	5418	330	43	04-72	111ALFP	--	6	S	--	H
SC01906913CAB	--	5098	14	9	07-62	111ALFP	--	30	J	F	H
SC01906913DAA	1963	5080	21	--	--	211FRHS	--	24	--	--	N
SC01906913DAB	1963	5080	20	--	--	211FRHS	110	24	T	E	N
SC01906913DAD1	--	5080	23	--	--	211FRHS	--	24	T	--	N
SC01906913DAD2	1956	5080	23	--	--	211FRHS	65	24	T	E	N
SC01906914DCC	--	5105	5	2	--	--	--	24	--	--	I
SC01906914DCD1	1906	5101	959	F	04-72	211DKOT	30	--	--	--	C
SC01906914DCD2	1930	5101	1059	F	07-62	211DKOT	64	6	--	--	C
SC01906915CAB	--	5142	13	3	07-62	--	--	26	--	--	H
SC01906916BAD1	--	5155	36	5	04-72	111ALFP	--	8	C	--	S
SC01906916BAD2	--	5155	10	7	04-72	111ALFP	--	12	--	--	S

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FREMONT COUNTY -- CONTINUED											
SC01906916BAD3	--	5155	22	--	--	111ALFP	--	8	J	E	H
SC01906916CAA	1951	5155	20	6	04-72	111ALFP	--	20	T	F	P
SC01906916CAB	1910	5150	40	6	05-72	111ALFP	--	12	T	E	P
SC01906917ABD	--	6182	45	12	01-62	111ALFP	--	--	T	F	I
SC01906919CAA	1968	--	47	--	--	111ALFP	--	8	S	E	P
SC01906921ABD	1963	5160	55	30	10-63	111ALFP	100	7	B	--	U
SC01906922BAC	--	5160	65	--	--	111ALFP	300	7	T	E	S
SC01906922BBC	1971	5180	65	35	02-71	111ALFP	30	6	S	E	S
SC01906924CAC	--	5190	1100	F	04-72	211DKOT	12	8	--	--	I
SC01906924CBD	--	5185	1100	F	04-72	--	50	8	--	--	I
SC01906927CAD	--	5340	4664	--	--	--	--	--	--	--	--
SC01906934DAB	--	5302	1500	29	07-62	211PIPR	--	--	--	--	--
SC01907001CCA	--	5226	3200	--	--	--	--	--	--	--	H
SC01907003DCD	1963	5390	52	32	03-72	111ALFP	35	7	J	E	I
SC01907003DDD	--	5360	28	16	07-62	111ALFP	--	36	--	--	U
SC01907004AAD	--	5385	90	41	07-62	--	--	7	--	--	I
SC01907004BDD	1954	5419	112	--	--	211DKOT	200	8	T	F	I
SC01907004CDB	1952	5468	270	67	11-71	211DKOT	1600	--	T	E	I
SC01907004DAB	--	5415	54	28	10-64	111ALFP	--	7	S	F	I
SC01907010ABB1	--	5400	34	21	11-71	111ALFP	--	30	J	E	I
SC01907010ABB2	--	5400	371	35	03-72	111ALFP	--	--	--	--	--
SC01907012AAC	1965	5210	11	8	04-72	111ALFP	--	30	C	E	I
SC01907012ABA	--	5200	25	--	--	111ALFP	--	--	T	F	H
SC01907012BAC	1956	5244	50	21	07-62	--	--	7	J	F	H
SC01907012DBB	--	5235	44	21	04-72	111ALFP	--	--	--	--	I
SC01907013ABC	--	5380	41	31	04-72	111ALFP	--	12	--	--	U
SC01907013BBC	--	5375	62	18	04-72	111ALFP	--	6	S	--	H
SC01907307CDB	--	6160	35	30	05-72	111ALFP	5	7	--	--	P
SC02006924ADD	--	5655	26	13	07-62	111VLFL	--	60	J	E	H
SC02006924CDB	--	6027	4156	--	--	111VLFL	--	--	--	--	--
SC02006925BCC	--	5760	30	20	07-62	111VLFL	--	30	P	--	H
SC02006934AAD	--	5905	38	29	07-62	--	--	36	J	E	D
SC02006936DCC	--	5885	22	15	07-62	--	--	24	--	--	S

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			LAKE	COUNTY							
SC00807910DDD	1964	10900	25	2	10-64	111VLFL	—	—	T	E	N
SC00807932DBD	1961	—	25	29	—	112GLCL	—	10	—	—	—
SC00808021ABD	1965	—	36	28	—	112GLCL	—	—	—	—	—
SC00907906BAD	1955	—	37	—	—	111VLFL	—	—	—	—	—
SC00908004AAA	—	—	40	3	—	111VLFL	—	6	—	—	—
SC00908009CBA1	1969	9450	70	6	07-69	111VLFL	250	—	—	—	H
SC00908009CBA2	1969	9450	68	5	07-69	111VLFL	250	—	—	—	H
SC00908010ACD	—	—	—	—	—	121DRUN	—	—	—	—	—
SC00908012ACA	—	—	—	—	—	112GLCL	—	—	—	—	—
SC00908012CAA	1967	10000	150	—	—	111VLFL	815	14	T	E	P
SC00908020DCB	—	—	—	—	—	111VLFL	—	—	—	—	—
SC00908021CAA	—	—	—	—	—	111VLFL	—	8	—	—	—
SC00908027DAB	—	—	—	—	—	111VLFL	—	—	—	—	—
SC00908027DBB	1959	9850	575	105	11-71	121DRUN	—	9	S	E	N
SC00908027DBC	1964	9800	477	53	11-71	121DRUN	180	12	S	E	N
SC00908029BAA	1963	9690	150	36	08-72	111VLFL	15	7	S	E	I
SC00908029BCD1	—	9615	—	—	—	—	—	—	T	E	—
SC00908032DAC	—	9555	50	—	—	111VLFL	—	—	—	—	P
SC00908032DAD	1970	9525	49	8	11-71	111VLFL	100	10	—	—	P
SC00908033BAD	1960	—	120	—	—	111VLFL	—	7	—	—	—
SC00908033CCD	1966	—	150	120	—	121DRUN	—	—	—	—	—
SC00908136ADD	—	—	70	—	—	111VLFL	—	—	—	—	—
SC01008004BDC	—	—	227	180	—	121DRUN	25	6	—	—	—
SC01008005BDC	1971	—	47	12	—	111VLFL	—	—	—	—	—
SC01008008ADC	—	9430	12	9	08-72	111VLFL	—	12	J	E	H
SC01008009ABC	1964	—	170	—	—	121DRUN	—	—	—	—	—
SC01008026BCD	1956	9350	36	19	08-72	121DRUN	—	6	C	E	H
SC01008034DCC	1964	9165	49	7	08-72	111VLFL	—	—	S	—	C
SC01008035DBB	1947	9400	28	—	—	121DRUN	—	7	J	E	H
SC01008035DCC	—	9185	34	13	08-72	112TERC	—	6	S	E	H
SC01108010CBD	—	9750	630	450	08-72	121DRUN	—	8	S	E	—

PUEBLO COUNTY

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM-ETER (IN)	TYPE LIFT	POWER	USE OF WATER
SC01806730CDB	1961	5720	375	—	—	211DKOT	—	—	—	—	S
SC01906517BDC1	—	5065	832	256	02-71	211DKOT	50	6	S	E	Z
SC01906517BDC2	1972	5065	1180	—	—	211DKOT	—	8	S	E	P
SC01906521BBA	1972	5044	1343	—	—	211DKOT	150	8	S	E	P
SC01906531CAA	—	5042	—	411	09-73	211DKOT	50	6	S	E	Z
SC01906701CDC	—	5305	556	F	06-66	211DKOT	—	—	—	—	H
SC01906709BBB	—	5398	675	—	—	211DKOT	—	—	—	—	S
SC01906719DAA	—	5249	—	—	—	211DKOT	—	—	P	—	S
SC01906722BDD	1967	5245	532	44	04-71	211DKOT	—	4	J	—	H
SC01906722DBB	—	5235	500	23	04-71	211DKOT	—	6	P	—	U
SC01906727BBB	—	5233	500	3	09-72	211DKOT	—	6	P	W	S
SC01906727DCD	—	5231	493	36	01-73	211DKOT	—	6	P	W	S
SC01906729CAA	1973	5200	777	30	05-73	211DKOT	100	8	S	E	C
SC02006501BBD	1959	4861	1631	32	08-59	217CYNN	—	6	—	—	H
SC02006508BBB	1969	5020	855	197	09-69	217CYNN	80	7	S	E	P
SC02006509ABC	—	4925	20	17	04-71	112TERC	—	—	J	E	H
SC02006511BAB	1972	5095	875	F	03-73	211DKOT	70	8	S	E	P
SC02006513ABC	—	4830	1395	55	—	211DKOT	40	7	S	E	N
SC02006513CBB	1947	4832	1501	F	—	211DKOT	200	8	—	—	C
SC02006526DCD1	1954	4675	25	12	09-62	111VLFL	100	36	T	E	N
SC02006526DCD2	1952	4675	24	12	09-62	111VLFL	100	36	T	E	N
SC02006531BDD	1965	4735	12	5	04-65	111VLFL	—	1	—	—	U
SC02006531DBC	—	4731	13	9	03-65	111VLFL	—	48	P	W	U
SC02006531DCD1	—	4718	33	6	04-72	111VLFL	—	6	—	—	—
SC02006531DCD2	—	4718	38	5	04-72	111VLFL	—	24	—	—	I
SC02006531DDC	1955	4723	42	16	09-62	111VLFL	750	24	T	E	I
SC02006532CAD	1965	4715	12	5	04-65	111VLFL	—	1	—	—	U
SC02006533ABC1	1934	4698	32	3	09-62	111VLFL	750	48	T	E	P
SC02006533ABC2	1934	4698	34	4	09-62	111VLFL	750	48	T	E	P
SC02006533ABC3	1934	4698	34	4	09-62	111VLFL	750	48	T	E	P
SC02006534ACA1	1932	4686	24	6	09-62	111VLFL	310	24	T	E	I
SC02006535ABA1	1956	4675	23	16	09-62	111VLFL	120	36	T	E	N
SC02006535ABA2	1952	4675	24	12	09-62	111VLFL	100	36	T	E	N
SC02006535BCB	1963	4730	863	3	06-73	211DKOT	30	5	S	E	I
SC02006536ACB	1954	4662	33	11	09-62	111VLFL	220	24	T	E	N

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PUEBLO COUNTY — CONTINUED											
SC02006536ACC	1941	4665	24	10	09-62	111VLFL	140	36	T	E	N
SC02006536BAA1	1957	4667	32	15	09-62	111VLFL	800	16	T	E	N
SC02006536BAA2	1960	4665	34	21	09-62	111VLFL	420	30	T	E	N
SC02006536BAD	1963	4665	1191	F	—	217CYNN	--	8	—	--	C
SC02006536BBA	1957	4667	24	11	09-62	111VLFL	200	24	T	E	I
SC02006536BBD	1957	4666	21	11	09-62	111VLFL	220	24	T	E	I
SC02006536BDB	1950	4665	24	10	09-62	111VLFL	180	48	T	E	N
SC02006536DBB	1957	4662	28	15	09-62	111VLFL	600	—	C	E	N
SC02006601BAD	1970	5048	830	117	05-71	211DKOT	--	6	S	E	P
SC02006602BAA	1972	5100	950	25	10-71	211DKOT	20	8	S	E	P
SC02006602BBB	1970	5120	876	95	05-71	211DKOT	—	8	--	--	U
SC02006603BDB	1971	5080	710	--	—	211DKOT	—	—	--	--	—
SC02006607AAA	1969	5040	865	194	02-71	211DKOT	—	8	S	E	P
SC02006608CDA	1969	5005	1040	92	—	217CYNN	108	8	S	E	Z
SC02006609CDA	—	5030	555	218	03-71	211DKOT	30	6	--	--	Z
SC02006611ACB	1969	5145	808	189	—	211DKOT	80	8	S	--	P
SC02006612DCA1	--	5075	748	283	07-71	217CYNN	--	--	S	E	P
SC02006612DCA2	—	5075	—	444	07-71	211DKOT	—	5	S	E	Z
SC02006614DAC	--	5090	510	330	03-71	211DKOT	—	9	—	--	U
SC02006616ACC	1969	4998	1035	140	03-71	217CYNN	80	7	--	—	P
SC02006622BAD	1969	4965	1510	F	04-71	217CYNN	50	8	S	--	P
SC02006624AAA	1972	5135	810	410	—	211DKOT	30	8	S	E	P
SC02006624BBB	1971	5191	847	444	09-71	211DKOT	280	10	S	E	U
SC02006624CAA	1971	5185	815	450	09-71	211DKOT	30	8	—	--	U
SC02006636DCD	1970	4852	248	160	07-70	211DKOT	20	5	S	E	H
SC02006703BCC	--	5325	—	197	03-73	211DKOT	—	6	S	—	S
SC02006704CAB	--	5140	3000	-1	02-71	317FNTN	—	10	--	—	U
SC02006706BAD	1950	4955	342	F	04-73	211DKOT	—	6	--	—	H
SC02006708ABA	--	4928	525	F	01-73	211DKOT	—	6	--	--	H
SC02006713BAD	1967	5020	214	87	10-71	211BGCK	--	7	S	F	S
SC02006714BAC	1967	5100	750	165	10-71	211DKOT	170	--	S	E	H
SC02006714DCC	1953	4870	580	F	—	217CYNN	--	10	--	--	P
SC02006715BDC	1954	4890	298	F	—	211DKOT	50	10	—	—	U
SC02006723BAB	1954	4880	358	F	10-71	211DKOT	--	—	--	—	U
SC02106505ABB2	--	4725	—	--	—	111VLFL	800	—	T	E	N

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PUEBLO COUNTY -- CONTINUED											
SCØ21Ø65Ø5ABD	1963	484Ø	941	--	--	221MRSN	28	6	S	--	I
SCØ21Ø65Ø5BAA	1953	4729	28	8	Ø9-62	111VLFL	7ØØ	24	T	E	I
SCØ21Ø651ØDDD	1964	4838	984	--	--	221MRSN	6Ø	4	S	E	I
SCØ21Ø6517DBB	--	5Ø3Ø	38Ø	48	Ø4-73	211DKOT	--	8	--	--	U
SCØ21Ø6519ACC	1957	5225	565	247	Ø3-71	211DKOT	25	6	--	--	U
SCØ21Ø6521AAA	1964	495Ø	6ØØ	F	Ø1-73	211DKOT	8Ø	8	S	--	S
SCØ21Ø6523DAD	1964	4848	1198	F	Ø1-73	211DKOT	1Ø	9	--	--	U
SCØ21Ø6528CDD	1962	5Ø58	56Ø	66	Ø3-72	211DKOT	--	5	--	--	U
SCØ21Ø6529DBB	--	5115	76Ø	--	--	--	--	--	P	G	S
SCØ21Ø653ØDCD	1959	5285	683	1.77	Ø3-73	211DKOT	--	--	--	--	U
SCØ21Ø6535BAA	1938	5Ø8Ø	1125	6	--	211DKOT	3	8	--	--	S
SCØ21Ø6612DBB	1964	5135	53Ø	276	Ø7-73	211DKOT	--	5	S	F	S
SCØ21Ø6619DBC	1969	5258	53Ø	127	Ø5-73	211DKOT	--	6	S	--	S
SCØ21Ø6624BBB	1971	5Ø4Ø	712	28	Ø3-73	211DKOT	2ØØ	--	--	--	U
SCØ21Ø6625DBB	197Ø	5Ø93	1Ø5Ø	F	Ø3-73	211DKOT	--	8	--	--	U
SCØ21Ø6626CAC	197Ø	5Ø45	1Ø35	F	Ø3-73	211DKOT	65	8	B	--	S
SCØ21Ø6632AAA	1968	--	534	--	--	211DKOT	--	8	P	W	S
SCØ21Ø6633DAA	197Ø	5175	1Ø25	Ø	Ø3-73	211DKOT	5ØØ	1Ø	--	--	I
SCØ21Ø6727DCC	1972	532Ø	485	38	Ø4-73	211DKOT	--	4	P	G	S
SCØ21Ø6729CCC	--	--	--	--	--	211DKOT	--	3	P	W	S
SCØ21Ø6731AAC	1973	648Ø	5ØØ	F	Ø5-73	221ENRD	--	--	--	--	U
SCØ21Ø6735ACD	1965	5455	342	312	Ø6-65	211DKOT	--	4	P	G	S
SCØ21Ø68Ø4BCD	--	5515	588	112	12-72	--	--	6	--	--	U
SCØ21Ø6811CCC	191Ø	5524	65Ø	144	Ø5-73	211DKOT	--	6	S	E	H
SCØ21Ø6815ADA	1963	557Ø	22ØØ	143	Ø9-72	211DKOT	--	1Ø	--	--	U
SCØ21Ø6815BAC	--	56ØØ	1Ø	1Ø	Ø9-72	111ALFP	--	48	J	E	S
SCØ21Ø6815CDC	1948	565Ø	511	26Ø	Ø9-72	211DKOT	--	6	S	E	H
SCØ22Ø65Ø2BCC1	1964	4959	644	--	--	211DKOT	15	6	--	--	H
SCØ22Ø65Ø2BCC2	--	4959	587	F	Ø3-73	211DKOT	--	5	--	--	U
SCØ22Ø65Ø3CDD	1964	5Ø3Ø	91Ø	F	--	217CYNN	5	9	--	--	U
SCØ22Ø652ØCAA	--	5Ø35	362	-32	Ø2-73	211DKOT	6Ø	--	--	--	I
SCØ22Ø6521BDB	1963	5Ø7Ø	495	36	--	211DKOT	2Ø	4	S	E	S
SCØ22Ø6521BDD	--	4985	21	14	Ø4-73	111VLFL	--	36	J	--	H
SCØ22Ø66Ø2CDD	--	5181	658	119	Ø5-72	211DKOT	--	5	S	E	S
SCØ22Ø66Ø3ABD	197Ø	517Ø	77Ø	81	Ø4-73	217CYNN	--	14	S	E	I

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM-ETER (IN)	TYPE LIFT	POWER	USE OF WATER
			PUEBLO COUNTY -- CONTINUED								
SC02206607DDB	--	5576	38	16	03-73	111ALFP	--	72	S	E	S
SC02206607DDC	1969	5605	510	402	02-73	211DKOT	--	6	S	E	H
SC02206609DAC	1971	5350	620	186	07-73	211DKOT	85	8	S	E	I
SC02206610CBB	--	5300	42	--	--	211FRHS	--	--	J	F	S
SC02206701ADB	1970	5380	425	138	--	211DKOT	15	5	S	E	S
SC02206701CAD	--	5310	30	--	--	111VLFL	--	36	S	F	H
SC02206701DBB	1962	5315	172	162	10-62	211DKOT	--	4	S	E	S
SC02206701DBC	--	5309	30	22	--	111ALFP	--	36	S	E	S
SC02206712BAB	1963	5373	210	160	04-73	211DKOT	--	4	S	E	S
SC02206713CCB	1962	5450	165	150	10-62	211DKOT	20	4	S	--	H
SC02206718BDD	1966	6155	135	121	04-73	211DKOT	--	7	S	E	H
SC02206722CCC	1965	5750	136	--	--	211DKOT	20	6	S	H	H
SC02206723ACB	1965	5450	117	79	04-73	211DKOT	--	6	S	E	H
SC02206728BDD	1971	5860	245	150	04-73	217CYNN	--	6	S	F	H
SC02206728CAA	1962	5865	225	200	10-62	217CYNN	--	4	S	F	H
SC02206728CAC1	1973	5905	214	185	04-73	211DKOT	15	6	S	E	H
SC02206728CAC2	--	5885	245	176	04-73	217CYNN	--	6	S	--	H
SC02206730DCB	1973	6110	300	203	03-73	217CYNN	--	5	S	E	H
SC02206731ABC	1972	6145	300	248	03-73	217CYNN	5	6	S	E	S
SC02206731ADD	1959	6122	325	305	04-73	217CYNN	--	5	S	E	H
SC02206731DBA	1971	6130	397	273	04-73	221MRSN	15	6	S	--	S
SC02206731DCA	1941	--	100	--	--	211DKOT	--	--	P	--	H
SC02206732CBB	1965	6102	435	300	04-73	221MRSN	15	6	S	F	S
SC02206811DDB	--	6560	400	324	04-73	221MRSN	--	--	--	--	U
SC02206812DCD	1914	6217	135	--	--	211DKOT	--	--	P	F	H
SC02206813DAB	--	5275	365	259	04-73	221MRSN	--	8	S	E	H
SC02306505BCC	1971	5330	500	168	06-72	211DKOT	--	6	S	E	H
SC02306506CDC	--	5420	650	193	04-73	211DKOT	--	6	S	E	P
SC02306507ACD	1972	5461	500	279	04-73	211DKOT	20	6	S	E	H
SC02306618BCC	1953	5610	600	--	--	221ENRD	--	4	S	--	H
SC02306620BAC	--	5320	185	120	04-73	211BGCK	--	6	P	--	S
SC02306620DDD	--	5830	535	278	04-73	--	--	12	--	--	U
SC02306628BBA	1969	5820	559	544	08-69	211DKOT	15	6	P	--	S
SC02306629ADD	1969	5670	314	65	05-69	211DKOT	--	6	P	G	S
SC02306632BBA	1971	5690	342	181	04-73	211DKOT	--	6	P	G	S

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI- TUDE- OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM- ETER (IN)	TYPE LIFT	POWER	USE OF WATER
			PUEBLO	COUNTY -- CONTINUED							
SCØ23Ø6632CDD	1971	584Ø	[illegible]	294	Ø4-73	211DKOT	15	6	P	G	S
SCØ23Ø6635BAB	—	54ØØ	25Ø	—	—	211DKOT	—	8	P	E	S
SCØ23Ø6635CCC	1923	54ØØ	887	1Ø6	Ø4-73	211DKOT	—	1Ø	S	E	S
SCØ23Ø67Ø3DCD	—	5912	4ØØ	—	—	211DKOT	—	—	P	E	H
SCØ23Ø67Ø6CBB2	—	6Ø35	86	62	Ø4-73	211DKOT	—	6	S	E	U
SCØ23Ø67Ø6CCB1	1971	6Ø3Ø	25Ø	62	Ø4-73	217CYNN	15	6	S	E	H
SCØ23Ø67Ø7CBD	1968	62ØØ	418	3Ø1	Ø3-73	221MRSN	15	5	S	E	S
SCØ23Ø67Ø7CCB	—	623Ø	57Ø	282	Ø3-73	221MRSN	—	6	S	E	S
SCØ23Ø6713ADA	1947	663Ø	13Ø	—	—	211DKOT	—	6	P	W	H
SCØ23Ø6722DCD	1968	583Ø	281	2ØØ	1Ø-68	211DKOT	12	6	S	E	H
SCØ23Ø6724BBC	197Ø	5712	315	181	Ø3-73	217CYNN	8Ø	1Ø	S	E	T
SCØ23Ø6726AAC	1969	578Ø	253	154	Ø3-73	211DKOT	55	8	—	—	U
SCØ23Ø6726BBA1	—	5778	146	129	Ø3-73	211DKOT	—	6	—	—	U
SCØ23Ø6726BBA2	1969	578Ø	181	126	Ø3-73	211DKOT	17Ø	8	S	F	S
SCØ23Ø6727ACB	1969	586Ø	38Ø	198	Ø3-73	211DKOT	18Ø	8	—	—	U
SCØ23Ø6728ACA	—	5895	38	15	Ø3-73	211DKOT	—	72	J	E	H
SCØ23Ø6734AAD	197Ø	59Ø5	5Ø5	261	Ø3-73	211DKOT	1Ø	6	S	E	S
SCØ23Ø6735ADD	1969	6Ø45	5ØØ	426	Ø5-69	211DKOT	12	6	P	G	S
SCØ23Ø6735CCC	1969	6Ø8Ø	51Ø	213	Ø7-73	211DKOT	12	6	S	G	S
SCØ23Ø6735DDC	1969	592Ø	495	389	Ø1-73	211DKOT	—	6	S	E	H
SCØ23Ø6736AAA	1969	594Ø	295	16Ø	Ø4-73	211BGCK	14	6	P	G	S
SCØ23Ø68Ø1AAD	196Ø	613Ø	247	125	Ø4-73	211DKOT	—	6	S	E	H
SCØ23Ø68Ø1ADA	1947	—	15Ø	—	—	211DKOT	—	6	S	E	H
SCØ23Ø68Ø1CDB	1958	626Ø	335	14Ø	Ø4-73	217CYNN	—	5	S	E	H
SCØ23Ø68Ø1DAA	—	6Ø95	164	111	Ø4-73	211DKOT	—	6	S	E	H
SCØ23Ø68Ø1DCB	1962	6219	295	21Ø	Ø4-73	217CYNN	3Ø	1Ø	—	—	U
SCØ23Ø68Ø2CCC	—	6238	35	—	—	111VLFL	—	—	J	E	H
SCØ23Ø681ØBDD	—	6362	74Ø	F	Ø4-73	317FNTN	1Ø	1Ø	—	—	U
SCØ23Ø6812AAC	1969	6119	172	61	Ø3-73	211DKOT	2ØØ	8	—	—	I
SCØ23Ø6813BAD	1969	641Ø	119	—	—	211DKOT	2ØØ	1Ø	—	—	I
SCØ23Ø6814ADD	—	6585	—	—	—	211DKOT	—	—	S	—	H
SCØ23Ø6821AAC	1959	686Ø	457	F	—	317FNTN	25	6	S	E	S
SCØ23Ø6824BBD	1968	632Ø	467	312	Ø4-73	211DKOT	4Ø	8	—	—	U
SCØ23Ø6824BDC	1967	633Ø	558	3Ø8	Ø4-73	211DKOT	79	8	—	—	U
SCØ23Ø6824DAD	—	624Ø	4ØØ	—	—	211DKOT	—	6	P	E	U

LOCAL WELL NUMBER	DATE DRILLED (YEAR)	ALTI-TUDE OF LSD (FT)	WELL DEPTH (FT)	WATER LEVEL (FT)	DATE WATER LEVEL MEASURED	MAJOR AQUIFER	YIELD (GPM)	CASING DIAM-ETER (IN)	TYPE LIFT	POWER	USE OF WATER
PUEBLO COUNTY -- CONTINUED											
SC02406609CDB	1967	5670	359	109	04-73	211DKOT	--	6	P	G	S
SC02406616CAB	1973	5795	600	222	03-73	211DKOT	--	8	--	--	C
SC02406617ADA	1972	5801	500	250	12-72	211DKOT	15	6	S	E	P
SC02406617DAB	1963	5793	477	215	01-73	211DKOT	20	--	--	--	U
SC02406618CCC	1963	5780	1300	--	--	211DKOT	370	8	T	E	P
SC02406619CDA	1971	5842	896	--	--	211DKOT	240	10	S	E	F
SC02406620BBB	1968	5702	500	95	02-68	211DKOT	16	8	S	E	H
SC02406620CAD	1965	5775	635	185	02-73	211DKOT	250	10	--	--	U
SC02406621BAC	--	5618	7	2	03-73	111AVMT	--	--	--	--	S
SC02406631BAA	1972	6019	333	249	02-73	217CYNN	--	--	--	--	U
SC02406701CDA	--	5895	70	--	--	211FRHS	--	6	U	E	H
SC02406701DBC	--	5945	530	--	--	211DKOT	--	6	S	E	H
SC02406702ABD	1969	5890	113	58	--	211FRHS	15	6	S	E	S
SC02406702DBB	1969	6090	585	184	04-67	211DKOT	12	6	P	E	S
SC02406712ACC	1960	5890	620	323	03-73	211DKOT	12	6	S	E	H
SC02406714CAD	1952	6020	485	97	07-73	211DKOT	--	6	S	F	H
SC02406720DAD	1967	7005	153	79	05-73	211DKOT	80	8	--	--	U
SC02406721ACB	1967	7080	134	69	05-73	211DKOT	10	6	--	--	U
SC02406722ACA	1964	6141	313	159	03-73	217CYNN	250	--	S	F	R
SC02406724DBC	1963	5865	820	F	12-72	217CYNN	--	12	--	--	H
SC02406725CCC	--	6150	350	311	04-73	211DKOT	--	6	P	G	S
SC02406726BAB	--	6020	22	16	--	111ALFP	--	40	S	--	H
SC02406727CBC 1/	--	6215	--	--	--	211DKOT	--	--	--	--	P
SC02406729DDC 1/	--	6220	--	--	--	211DKOT	--	--	--	--	H
SC02406730CAC	1972	6835	485	160	02-73	211DKOT	--	10	--	--	U
SC02406730DBA	--	6765	286	187	02-73	217CYNN	--	10	--	--	U
SC02406731BBC	1964	6920	700	289	02-73	211DKOT	120	9	S	E	P
SC02406732AAA	1969	6460	190	140	05-73	211CDLL	30	5	S	E	H
SC02406732AAB	1966	6520	170	0	--	211DKOT	5	5	S	--	H
SC02406733ACB 1/	--	6355	--	--	--	111AVMT	--	--	--	--	P
SC02406736BCD	1964	6080	400	365	04-73	221MRSN	12	6	S	E	H
SC02406810BDA	--	7640	10	5	07-73	111ALFP	--	96	--	--	H
SC02406814DCC1	1957	7210	357	332	05-73	217CYNN	--	5	--	--	U
SC02406814DCC2	--	7205	56	28	05-73	111ALFP	--	6	S	--	H
SC02406823BAA	1948	7201	160	--	--	211DKOT	--	6	S	E	H
SC02506705BBA	1968	6685	42	--	--	112TERC	--	6	S	E	H
SC02506711AAA	--	6098	465	38	04-73	211DKOT	--	8	S	E	S

GEOLOGIC LOG OF TEST WELL SC01407830DAA

SC01407830DAA, drilled near Buena Vista, Colo.

Location: Chaffee County, Colo.
Altitude of land surface: Approximately 8,086 feet above mean sea level.
Method drilled: Hydraulic rotary.
Casing record: Steel, 6-inch I.D., to 66 feet below land surface (cemented).
Galvanized pipe, 2-inch I.D., to 1,000 feet.
Perforated intervals: 599-641 and 767-1,000 feet.
Date drilled: 9-29-71 to 10-4-71.
Water level: Approximately 26 feet below land surface.

	Thickness (feet)	Depth (feet)
Quaternary deposits:		
Sand, silty, micaceous; contains scattered weathered granite cobbles	5	5
Gravel, very fine to medium, grading to buff clayey sand	15	20
Dry Union (?) Formation:		
Gravel, very coarse to fine; contains some cobbles and scattered yellowish-gray clay lenses	20	40
Gravel, medium to very coarse, clayey	20	60
Gravel, fine to medium, and sand, silty to clayey	30	90
Clay, rusty, micaceous; contains fine to very fine gravel	20	110
Sand, coarse to very coarse; contains rusty clay streaks	5	115
Clay, rusty to brown; contains very coarse angular sand and very fine angular gravel, grading to coarse clay-filled gravel	20	140
Clay, yellowish-gray to white, very sandy, grading to fine, clay-filled gravel	20	160
Sand, poorly sorted, clay-filled, grading to silty sand	40	200
Sand, medium to very coarse; contains yellowish-gray and rusty clay streaks. (Possibly some cemented sand.)	40	240
Sand, poorly sorted, clayey; contains some very fine gravel and yellow limonite-stained clay stringers	80	320
Sand; contains intergranular clay	25	345
Sand, clayey; contains cemented sand beds and clay stringers	40	385
Sand, fine to medium, micaceous; contains some intergranular clay	20	405
Sand, medium to coarse; contains scattered cobbles, some cemented beds, and clay streaks	65	470
Sand, medium to coarse, clayey	50	520

	Thickness (feet)	Depth (feet)
Dry Union (?) Formation--Continued:		
Sand, very coarse to very fine gravel, grading from clayey to silty; contains scattered cobbles(?)------	80	600
Sand and very fine to medium gravel; contains cememted and clayey streaks----------------------------------	50	650
Sand and very fine gravel, grading to silty and clayey sand--	40	690
Sand, clayey to silty; contains local concentration of magnetite-------------------------------------	80	770
Gravel, very coarse to medium, and sand; contains cemented beds and yellowish-gray clay stringers-----	70	840
Sand and very fine gravel, clayey; contains scattered cemented beds--------------------------------------	50	890
Sand, poorly sorted, silty to clayey; contains stringers of yellowish-brown sandy clay------------------	40	930
Sand, clayey; contains scattered cobbles--------------	30	960
Sand to fine gravel, poorly sorted; contains stringers of yellowish-gray clay, grading to poorly sorted sand and gravel-------------------------------------	40	1,000

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS

EXPLANATION OF HEADING INFORMATION

LOCAL IDENTIFIER = LOCAL WELL NUMBER

GEOLOGIC UNITS:

111ALFP = ALLUVIAL FLOOD PLAIN DEPOSITS
111AVMT = ALLUVIAL TERRACE DEPOSITS
111VLFL = VALLEY FILL DEPOSITS
112GLCL = GLACIAL DEPOSITS
112SNTF = SANTA FE FORMATION
112TERC = TERRACE DEPOSITS
120TRTR = TERTIARY SYSTEM UNDIVIDED
120VLCC = TERTIARY VOLCANICS
121DRUN = DRY UNION FORMATION
210DKOT = DAKOTA SANDSTONE (UPPER PART OF DAKOTA-PURGATOIRE AQUIFER)
211BGCK = BRIDGE CREEK LIMESTONE MEMBER OF THE GREENHORN LIMESTONE
211CDLL = CODELL SANDSTONE MEMBER OF THE CARLILE SHALE
211FRHS = FORT HAYS LIMESTONE MEMBER OF THE NIOBRARA FORMATION
217CYNN = LYTLE SANDSTONE MEMBER (EQUIVALENT TO CHEYENNE SANDSTONE) OF THE PURGATOIRE FORMATION (LOWER PART OF THE DAKOTA-PURGATOIRE AQUIFER)
224ENRD = ENTRADA SANDSTONE
221MRSN = MORRISON FORMATION
317FNTN = FOUNTAIN FORMATION
400PCMB = PRECAMBRIAN ROCKS

SITE CODES:

GW = WELL
SP = SPRING

UNITS:

DEG C = DEGREES CELSIUS
MICROMHOS = MICROMHOS PER CENTIMETER AT 25 DEGREES CELSIUS
MG/L = MILLIGRAMS PER LITER
UG/L = MICROGRAMS PER LITER

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	SITE	DATE OF SAMPLE	PH FIELD (UNITS)	TEMPER-ATURE, WATER (DEG C)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	HARD-NESS (MG/L AS CACO3)
				CHAFFEE						
NA04900701DDB	112GLCL	GW	72-11-15	8.3	10.0	313	189	51	7.1	160
NA04900804ADA	121DRUN	GW	75-10-17	7.5	10.0	430	252	59	13	200
NA04900905DAD	121DRUN	GW	73-04-27	8.6	15.0	509	339	9.4	.2	24
NA04900907BDA	121DRUN	GW	75-06-05	7.8	11.5	300	180	38	6.8	120
NA04900907CDA	121DRUN	GW	75-06-05	7.7	13.0	460	259	51	10	170
NA04900908ABC	121DRUN	GW	75-10-14	7.2	12.5	465	255	58	13	200
NA04900910CDA	111VLFL	GW	73-04-27	7.4	10.5	555	344	67	13	220
NA05000734CCD	111VLFL	GW	75-10-17	6.1	11.5	110	66	13	2.5	43
NA05000803BDA	121DRUN	GW	73-04-27	7.7	13.0	696	478	96	5.0	260
NA05000803BDC	121DRUN	GW	75-10-16	7.7	13.0	640	384	83	9.9	250
NA05000822DAB	111VLFL	SP	75-10-16	7.3	10.5	500	291	77	8.9	230
NA05000825BCC	111VLFL	SP	75-10-16	6.7	13.0	540	316	83	12	260
NA05000825DDB	112GLCL	SP	73-04-27	8.0	14.5	340	203	58	6.8	170
NA05000828ABD	121DRUN	GW	75-10-16	7.6	11.5	470	283	57	3.7	160
NA05000828DDD	121DRUN	SP	75-10-16	8.2	7.0	340	192	37	15	150
NA05000832CAC	121DRUN	GW	75-10-17	7.8	10.0	395	230	47	20	200
NA05000835DCC	121DRUN	GW	73-04-27	7.8	9.5	349	219	46	14	170
NA05000930BCC	121DRUN	GW	75-10-16	7.6	11.5	400	227	58	8.8	180
NA05000931BAB	111VLFL	GW	73-04-27	7.7	15.0	436	263	72	8.9	220
NA05000931CDC	111VLFL	GW	75-10-17	7.8	11.5	460	258	49	15	180
NA05100713BCB	121DRUN	GW	75-06-04	6.9	10.0	124	82	16	1.3	45
NA05100809DAB	121DRUN	GW	75-10-15	7.4	11.0	295	163	35	11	130
NA05100821BCB	121DRUN	GW	75-06-04	9.1	14.0	163	108	9.6	.1	24
NA05100833ADA	121DRUN	GW	72-11-17	8.2	21.0	989	597	60	.3	150
SC01107931CDA	111VLFL	GW	72-08-31	7.1	11.0	422	250	48	10	160
SC01207916CCC	111VLFL	GW	72-08-31	6.7	9.5	152	98	19	3.1	60
SC01207934BBC	121DRUN	GW	75-06-18	7.3	10.0	218	138	24	3.8	76
SC01207934DBA	111VLFL	GW	72-08-31	7.2	13.0	267	164	32	6.9	110
SC01307831BDB	112GLCL	GW	72-08-31	7.6	15.0	384	233	52	12	180
SC01307927ACA	121DRUN	GW	75-06-18	7.8	11.0	146	97	18	2.8	56
SC01307928AAD	121DRUN	GW	75-06-18	7.6	11.0	87	65	12	2.0	38
SC01407805BAD	112GLCL	GW	72-11-14	7.9	17.0	177	110	20	4.2	67
SC01407807BBB	121DRUN	GW	75-06-18	7.7	12.0	151	100	23	2.9	69

LOCAL IDENT- I- FIER	SODIUM DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY (MG/L AS CACO3)	BICAR- BONATE (MG/L AS HCO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	PHOS- PHORUS, ORTHOPH OSPHATE DISSOL. (MG/L AS P)
CHAFFEE										
NA04900701DDB	3.5	.1	1.8	150	183	17	1.4	.6	.04	.040
NA04900804ADA	14	.4	.6	211	257	14	.6	.8	.76	.010
NA04900905DAD	110	9.7	1.6	226	247	35	7.3	2.6	.06	.030
NA04900907BDA	18	.7	1.8	135	165	16	2.4	.7	.00	.010
NA04900907CDA	26	.9	2.2	195	238	25	6.1	1.6	.22	.040
NA04900908ABC	15	.5	2.0	215	262	15	3.2	.8	.50	.010
NA04900910CDA	29	.9	3.3	157	192	82	18	.8	5.3	.010
NA05000734CCD	2.9	.2	1.0	26	32	17	.6	.6	.08	.000
NA05000803BDA	45	1.2	2.1	182	222	130	11	1.1	9.4	.020
NA05000803BDC	27	.7	1.3	112	136	140	25	.6	2.7	.010
NA05000822DAB	15	.4	2.0	252	307	17	1.0	.6	.31	.020
NA05000825BCC	14	.4	3.7	281	342	13	1.8	.6	.41	.030
NA05000825DDB	5.1	.2	2.1	158	193	21	2.7	.6	.08	.010
NA05000828ABD	42	1.5	1.0	205	250	19	8.6	.5	2.8	.000
NA05000828DDD	9.3	.3	1.0	158	193	12	1.8	.8	.16	.000
NA05000832CAC	6.6	.2	.7	187	228	15	2.8	.6	.58	.020
NA05000835DCC	12	.4	2.6	162	197	18	4.3	.8	.81	.010
NA05000930BCC	9.2	.3	2.0	176	214	21	1.4	.5	.83	.000
NA05000931BAB	8.7	.3	2.4	203	247	27	3.7	.5	.60	.040
NA05000931CDC	20	.6	3.4	218	266	16	3.2	.9	.81	.010
NA05100713BCB	6.8	.4	1.2	47	57	5.1	.8	1.7	.08	.020
NA05100809DAB	3.8	.1	.9	128	156	10	.9	1.4	.21	.010
NA05100821BCB	30	2.6	.8	64	58	12	1.5	1.2	.40	.010
NA05100833ADA	140	5.0	2.9	188	229	190	49	2.0	1.4	.020
SC01107931CDA	17	.6	3.8	142	173	32	15	.9	4.2	.020
SC01207916CCC	5.4	.3	1.4	58	71	15	1.3	.4	.28	.010
SC01207934BBC	14	.7	1.8	97	118	13	1.5	.4	.16	.000
SC01207934DBA	14	.6	2.3	113	138	22	2.4	.6	.39	.010
SC01307831BDB	5.0	.2	1.5	133	162	18	8.2	.3	8.3	.040
SC01307927ACA	6.4	.4	1.1	62	75	3.5	2.7	.3	.89	.010
SC01307928AAD	4.7	.3	.9	42	51	2.0	.8	.1	.09	.000
SC01407805BAD	7.0	.4	1.3	60	73	25	2.1	.3	.54	.000
SC01407807BBB	4.9	.3	1.1	67	82	6.7	.9	.5	.20	.020

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	SILICA, DIS-SOLVED (MG/L AS SIO2)	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)	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	ZINC, DIS-SOLVED (UG/L AS ZN)
			CHAFFEE					
NA04900701DDB	16	--	9	--	0	--	--	--
NA04900804ADA	20	--	10	--	0	--	--	--
NA04900905DAD	37	--	50	2	0	--	--	20
NA04900907BDA	14	--	520	--	0	--	--	--
NA04900907CDA	19	--	0	--	0	--	--	--
NA04900908ABC	17	--	0	--	0	--	--	--
NA04900910CDA	12	10	50	3	20	--	--	160
NA05000734CCD	12	--	70	--	0	--	--	--
NA05000803BDA	36	10	30	2	20	--	--	130
NA05000803BDC	18	--	10	--	0	--	--	--
NA05000822DAB	17	--	10	--	0	--	--	--
NA05000825BCC	17	--	10	--	0	--	--	--
NA05000825DDB	11	10	50	2	0	--	--	10
NA05000828ABD	16	--	10	--	0	--	--	--
NA05000828DDD	19	--	10	--	0	--	--	--
NA05000832CAC	22	--	10	--	0	--	--	--
NA05000835DCC	20	--	30	2	0	--	--	40
NA05000930BCC	17	--	0	--	0	--	--	--
NA05000931BAB	15	10	50	3	10	--	--	30
NA05000931CDC	16	--	0	--	0	--	--	--
NA05100713BCB	21	--	40	--	0	--	--	--
NA05100809DAB	22	--	0	--	0	--	--	--
NA05100821BCB	12	--	250	--	0	--	--	--
NA05100833ADA	34	--	9	--	10	--	--	--
SC01107931CDA	17	--	170	--	2400	--	--	--
SC01207916CCC	16	--	50	--	0	--	--	--
SC01207934BBC	21	--	40	--	5	--	--	--
SC01207934DBA	14	--	170	--	10	--	2	1900
SC01307831BDB	19	--	20	--	0	--	--	--
SC01307927ACA	21	--	20	--	0	--	--	--
SC01307928AAD	17	--	0	--	0	--	--	--
SC01407805BAD	12	--	30	--	0	--	--	--
SC01407807BBB	19	--	0	--	0	--	--	--

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT- I- FIER	GEO- LOGIC UNIT	SITE	DATE OF SAMPLE	PH FIELD (UNITS)	TEMPER- ATURE, WATER (DEG C)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	HARD- NESS (MG/L AS CACO3)
				CHAFFEE						
SC01407821BCB	121DRUN	GW	75-06-19	7.5	11.0	302	174	44	9.3	150
SC01407822ADD	400PCMB	GW	72-11-15	8.7	15.0	1060	720	120	33	440
SC01407834DBA	111VLFL	GW	72-11-15	8.2	13.0	221	139	23	8.9	94
SC01407901DBB	121DRUN	GW	75-06-18	8.0	11.0	159	104	19	3.7	63
SC01407914CBB	121DRUN	GW	72-11-15	8.0	16.5	157	101	16	4.2	57
SC01407925BCB	121DRUN	GW	75-06-19	6.8	8.0	197	126	30	3.4	89
SC01407926BBB	121DRUN	GW	75-06-18	7.9	10.0	137	83	17	3.6	57
SC01407926BDB	121DRUN	GW	75-06-18	8.3	10.0	179	110	27	2.8	79
SC01507823DAB	111VLFL	GW	75-10-15	7.3	9.0	465	237	62	6.3	180
SC01507826BCB	111VLFL	SP	75-10-15	6.8	9.5	295	171	41	6.2	130
SC01507826BDB	111VLFL	GW	75-10-15	7.4	11.5	340	198	49	6.6	150
SC01507828CCA	121DRUN	GW	75-10-15	7.6	9.5	235	132	31	2.9	89
SC01507832AAB	111VLFL	GW	72-11-16	7.0	14.5	169	113	23	3.0	70
SC01507834AAC	121DRUN	GW	75-10-15	7.3	11.0	338	193	42	11	150
SC01507834CCD	121DRUN	GW	75-10-15	7.7	11.0	163	98	27	3.0	80
SC01507911DDA	121DRUN	GW	72-11-16	6.4	8.0	95	71	16	1.5	46
SC01507924BDD	111VLFL	GW	72-11-16	7.9	63.0	329	262	11	.3	29

LOCAL IDENT-I-FIER	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	BICAR-BONATE (MG/L AS HCO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHORUS, ORTHOPH OSPHATE DISSOL. (MG/L AS P)
CHAFFEE										
SC01407821BCB	5.7	.2	2.4	149	182	7.2	.9	.2	.11	.000
SC01407822ADD	65	1.4	4.6	283	286	170	46	2.3	19	.040
SC01407834DBA	5.9	.3	1.8	98	120	14	2.4	.4	.83	.050
SC01407901DBB	7.4	.4	1.2	71	86	7.6	.9	.3	.16	.030
SC01407914CBB	9.0	.5	1.3	73	89	10	1.3	.1	.26	.010
SC01407925BCB	3.7	.2	.8	77	94	16	1.1	.1	.95	.010
SC01407926BBB	4.0	.2	1.6	62	75	5.8	1.1	.2	.15	.000
SC01407926BDB	7.7	.4	1.7	82	100	6.2	.9	.3	.03	.010
SC01507823DAB	11	.4	2.7	184	224	23	2.2	1.0	.36	.050
SC01507826BCB	9.3	.4	1.0	122	149	19	.9	1.0	.13	.040
SC01507826BDB	12	.4	1.1	148	180	21	1.1	1.1	.01	.030
SC01507828CCA	11	.5	1.1	92	112	11	2.3	.7	.40	.000
SC01507832AAB	7.8	.4	.9	75	91	10	2.3	1.0	.37	.020
SC01507834AAC	9.5	.3	1.4	148	181	12	2.2	1.2	1.0	.010
SC01507834CCD	1.9	.1	2.0	71	86	7.2	.6	1.1	.05	.010
SC01507911DDA	2.1	.1	.6	42	51	8.7	1.6	.2	.17	.020
SC01507924BDD	53	4.3	2.3	57	70	69	4.5	9.4	.09	.030

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	SILICA, DIS-SOLVED (MG/L AS SIO2)	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)	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	ZINC, DIS-SOLVED (UG/L AS ZN)
CHAFFEE								
SC01407821BCB	14	--	0	--	5	--	--	--
SC01407822ADD	25	--	9	--	0	--	--	--
SC01407834DBA	20	--	20	--	0	--	--	--
SC01407901DBB	21	--	0	--	0	--	--	--
SC01407914CBB	14	--	40	--	0	--	--	--
SC01407925BCB	20	--	10	--	0	--	--	--
SC01407926BBB	12	--	40	--	5	--	--	--
SC01407926BDB	14	--	10	--	0	--	--	--
SC01507823DAB	17	--	10	--	0	--	--	--
SC01507826BCB	18	--	10	--	0	--	--	--
SC01507826BDB	17	--	30	--	0	--	--	--
SC01507828CCA	15	--	0	--	0	--	--	--
SC01507832AAB	18	--	40	--	0	--	--	--
SC01507834AAC	20	--	10	--	0	--	--	--
SC01507834CCD	13	--	0	--	0	--	--	--
SC01507911DDA	14	--	60	--	10	--	--	--
SC01507924BDD	77	20	90	--	0	--	--	20

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	SITE	DATE OF SAMPLE	PH FIELD (UNITS)	TEMPER-ATURE, WATER (DEG C)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	HARD-NESS (MG/L AS CACO3)
				CUSTER						
NA04501202DAA	112TERC	GW	72-08-22	7.7	11.0	397	238	43	17	180
NA04601212DBC	112SNTF	GW	72-08-22	7.9	10.5	170	107	26	2.9	77
SC02106909DCA	210DKOT	GW	73-01-26	7.2	15.0	349	214	41	13	160
SC02106933AAA	210DKOT	GW	73-05-13	7.3	--	497	301	58	20	230
SC02107018DDB	400PCMB	GW	72-08-22	7.4	12.5	37	221	E44	14	170
SC02107308BDD	120VLCC	GW	72-08-22	7.4	15.0	590	367	82	14	260
SC02107328BDC	112SNTF	GW	72-08-18	7.5	9.5	262	157	34	7.2	110
SC02107334DBB	112SNTF	GW	72-08-18	7.7	10.5	226	139	27	7.9	100
SC02107335CDB	112SNTF	GW	72-08-22	7.5	12.5	273	169	34	10	130
SC02207214CDA	112SNTF	GW	72-08-16	7.6	15.5	493	305	60	17	220
SC02207217CAC1	120TRTR	GW	72-08-16	7.6	15.0	357	225	43	8.6	140
SC02207232AAB	112SNTF	GW	72-08-16	7.4	10.0	543	328	77	13	250
SC02207306ACB	112GLCL	GW	72-08-22	7.2	9.0	230	138	32	5.2	100
SC02207308DCA	112GLCL	GW	72-08-18	7.6	9.0	211	122	29	6.3	98
SC02207312DDC	112GLCL	GW	72-08-18	7.6	11.5	247	155	31	7.3	110
SC02207336DCC	112SNTF	GW	72-08-16	7.4	10.0	154	94	22	4.7	74
SC02307220CBC1	112GLCL	GW	72-08-16	7.6	10.0	324	188	46	8.6	150
SC02307224DBC	112GLCL	GW	72-08-16	7.6	15.0	329	207	44	6.5	140
SC02307226CBB	112GLCL	GW	72-08-16	7.9	10.5	217	138	30	4.9	95
SC02307304CAC	112GLCL	GW	72-08-18	7.7	9.0	266	157	41	5.8	130
SC02307315ADB	112SNTF	GW	72-08-18	7.6	8.0	292	162	42	8.7	140

LOCAL IDENT-I-FIER	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	BICAR-BONATE (MG/L AS HCO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHORUS, OPTHOPH OSPHATE DISSOL. (MG/L AS P)
CUSTER										
NA04501202DAA	14	.5	2.3	185	226	23	2.0	1.8	.01	.010
NA04601212DBC	4.6	.2	.7	87	106	2.6	.9	.1	.02	.010
SC02106909DCA	13	.5	3.3	172	210	20	2.2	.4	.08	.000
SC02106933AAA	17	.5	3.9	208	253	44	6.4	.5	.02	.010
SC02107018DDB	9.7	.3	3.9	179	218	20	2.4	.3	--	--
SC02107308BDD	21	.6	2.1	220	268	82	7.1	.5	.51	.020
SC02107328BDC	7.5	.3	1.4	124	151	9.5	2.3	.2	.52	.010
SC02107334DBB	5.6	.2	1.1	93	113	22	1.0	.2	.43	.010
SC02107335CDB	8.0	.3	.9	122	149	21	.9	.2	.16	.010
SC02207214CDA	12	.4	2.8	157	192	48	25	.6	3.6	.020
SC02207217CAC1	17	.6	2.6	150	183	21	8.2	.6	1.1	.030
SC02207232AAB	16	.4	4.8	273	333	13	6.8	.4	.00	.310
SC02207306ACB	7.9	.3	.4	112	136	8.5	.9	.2	.12	.000
SC02207308DCA	3.0	.1	1.0	95	116	15	.8	.2	.09	.010
SC02207312DDC	9.4	.4	1.4	119	145	11	1.2	.2	.11	.010
SC02207336DCC	3.8	.2	1.0	70	85	8.5	.9	.1	.06	.000
SC02307220CBC1	9.0	.3	1.4	162	198	7.2	1.2	.2	.75	.020
SC02307224DBC	13	.5	3.5	157	191	11	3.8	.6	.29	.070
SC02307226CBB	6.5	.3	1.2	101	123	7.4	3.3	.3	.42	.030
SC02307304CAC	4.7	.2	.9	139	170	4.7	.9	.1	.07	.020
SC02307315ADB	5.4	.2	1.4	144	176	6.4	.8	.1	.21	.010

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT- I- FIER	SILICA, DIS- SOLVED (MG/L AS SIO2)	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)	MERCURY DIS- SOLVED (UG/L AS HG)	SELE- NIUM, DIS- SOLVED (UG/L AS SE)	ZINC, DIS- SOLVED (UG/L AS ZN)
CUSTER								
NA04501202DAA	19	--	4200	--	230	--	--	--
NA04601212DBC	17	--	20	--	0	--	--	--
SC02106909DCA	17	--	400	--	20	--	--	--
SC02106933AAA	25	4	140	3	140	--	--	310
SC02107018DDB	19	--	20	--	--	--	--	--
SC02107308BDD	24	--	30	--	40	--	--	--
SC02107328BDC	18	--	110	--	10	--	--	--
SC02107334DBB	17	--	40	--	0	--	--	--
SC02107335CDB	20	--	20	--	0	--	--	--
SC02207214CDA	29	--	20	--	0	--	--	--
SC02207217CAC1	29	--	120	--	10	--	--	--
SC02207232AAB	27	--	6000	--	3	--	--	--
SC02207306ACB	15	--	60	--	30	--	--	--
SC02207308DCA	9.5	--	50	--	10	--	--	--
SC02207312DDC	22	--	100	--	20	--	--	--
SC02207336DCC	11	--	240	--	40	--	--	--
SC02307220CBC1	14	--	20	--	0	--	--	--
SC02307224DBC	29	--	20	--	0	--	--	--
SC02307226CBB	22	--	60	--	0	--	--	--
SC02307304CAC	15	--	50	--	0	--	--	--
SC02307315ADB	10	--	30	--	10	--	--	--

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	SITE	DATE OF SAMPLE	PH FIELD (UNITS)	TEMPER-ATURE, WATER (DEG C)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	HARD-NESS (MG/L AS CACO3)
				FREMONT						
NA04801129ACC	111VLFL	GW	73-04-27	7.7	11.0	884	534	63	16	220
NA04801231BBD	111VLFL	GW	73-04-29	7.7	--	898	566	55	42	310
SC01707004ACB	317FNTN	GW	72-09-13	7.8	13.5	693	427	55	32	270
SC01707130CCC	210DKOT	GW	72-04-22	7.0	15.0	626	402	73	19	260
SC01807109DAA	210DKOT	GW	73-04-26	7.8	13.0	835	506	60	43	330
SC01906807CCA	210DKOT	GW	71-12-01	6.6	31.5	2390	1530	160	71	690
	210DKOT	GW	72-09-12	6.5	31.0	2370	1530	170	73	720
SC01906812BCC	210DKOT	GW	73-01-27	9.3	13.5	313	200	4.2	6.3	36
SC01906813CDD	210DKOT	GW	73-01-26	7.3	18.0	850	540	72	31	310
SC01906814CAD	211FRHS	GW	73-01-27	7.0	13.5	3140	2870	560	150	2000
SC01906823BAB	210DKOT	GW	73-01-25	6.9	--	2420	1710	220	98	960
SC01906830BCA	210DKOT	GW	72-09-12	6.8	55.0	2330	1520	160	70	690
SC01906916BAD3	111ALFP	GW	72-04-15	7.4	13.5	949	643	110	24	370

LOCAL IDENT-I-FIER	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	BICAR-BONATE (MG/L AS HCO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHORUS, ORTHOPH OSPHATE DISSOL. (MG/L AS P)
				FREMONT						
NA04801129ACC	95	2.8	5.1	196	239	100	94	.8	3.1	.010
NA04801231BBD	86	2.1	9.2	300	366	71	99	1.2	1.4	.030
SC01707004ACB	36	1.0	17	244	298	100	16	2.9	1.6	.010
SC01707130CCC	33	.9	6.5	224	273	100	13	1.2	.01	.000
SC01807109DAA	42	1.0	8.0	171	208	170	64	1.2	.14	.010
SC01906807CCA	290	4.8	32	1001	1220	230	120	1.4	.00	.030
	280	4.5	22	992	1210	240	120	1.3	.05	.020
SC01906812BCC	46	3.3	9.0	104	88	67	9.3	.3	.43	.040
SC01906813CDD	70	1.7	11	279	340	170	6.5	1.2	.03	.000
SC01906814CAD	100	1.0	7.6	372	454	1800	14	.9	.80	.020
SC01906823BAB	290	4.1	26	1130	1380	290	91	.6	.10	.010
SC01906830BCA	280	4.6	33	960	1170	230	130	1.2	.17	.030
SC01906916BAD3	65	1.5	5.0	262	319	240	12	.7	1.6	.010

LOCAL IDENT- I- FIER	SILICA, DIS- SOLVED (MG/L AS SIO2)	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)	MERCURY DIS- SOLVED (UG/L AS HG)	SELE- NIUM, DIS- SOLVED (UG/L AS SE)	ZINC, DIS- SOLVED (UG/L AS ZN)
			FREMONT					
NA04801129ACC	27	10	80	3	10	--	--	120
NA04801231BBD	15	--	30	2	10	--	--	90
SC01707004ACB	14	--	30	--	0	--	--	--
SC01707130CCC	14	--	8100	--	240	--	--	--
SC01807109DAA	11	--	90	2	340	--	--	240
SC01906807CCA	30	--	0	--	40	--	--	--
	28	--	900	--	30	1.6	--	--
SC01906812BCC	.4	--	110	--	0	--	--	70
SC01906813CDD	9.7	--	1700	--	20	--	--	20
SC01906814CAD	13	--	1100	--	240	--	--	520
SC01906823BAB	9.8	--	3800	--	130	--	--	30
SC01906830BCA	34	2	60	--	0	--	--	--
SC01906916BAD3	22	10	60	--	30	.1	--	30

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	SITE	DATE OF SAMPLE	PH FIELD (UNITS)	TEMPER-ATURE, WATER (DEG C)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	HARD-NESS (MG/L AS CACO3)
				LAKE						
SC00807910DDD	111VLFL	GW	72-08-29	6.1	10.5	169	95	18	4.2	62
SC00807932DBD	112GLCL	GW	75-06-10	7.4	3.0	180	104	23	8.2	91
SC00808021ABD	112GLCL	GW	75-06-10	6.9	5.0	70	51	7.6	3.0	31
SC00907906BAD	111VLFL	GW	75-06-10	8.0	5.0	240	148	36	13	140
SC00908004AAA	111VLFL	GW	75-06-04	6.5	6.0	175	97	17	5.6	66
SC00908009CBA1	111VLFL	GW	72-08-29	6.8	5.5	93	66	9.4	3.0	36
SC00908010ACD	121DRUN	GW	75-06-03	7.5	5.0	268	151	15	4.9	58
SC00908012ACA	112GLCL	GW	75-06-10	7.6	8.5	170	100	24	6.5	87
SC00908020DCB	111VLFL	GW	75-06-04	7.2	6.5	144	95	16	5.8	64
SC00908021CAA	111VLFL	GW	75-06-04	7.9	9.0	305	178	35	15	150
SC00908027DAB	111VLFL	GW	75-06-11	6.8	6.0	825	625	110	41	440
SC00908027DBB	121DRUN	GW	72-08-29	7.6	14.5	594	377	69	27	280
SC00908032DAC	111VLFL	GW	72-08-29	7.1	7.0	407	240	49	18	200
SC00908033BAD	111VLFL	GW	75-06-11	6.4	5.0	950	845	160	55	630
SC00908033CCD	121DRUN	GW	75-06-11	7.7	7.0	165	106	22	6.4	81
SC00908136ADD	111VLFL	GW	75-06-11	6.8	10.0	95	65	10	2.2	34
SC01008004BDC	121DRUN	GW	75-06-11	7.5	7.0	190	120	25	8.9	99
SC01008005BDC	111VLFL	GW	75-06-11	7.7	7.0	240	146	33	12	130
SC01008008ADC	111VLFL	GW	72-08-30	6.6	14.5	204	129	19	6.3	73
SC01008009ABC	121DRUN	GW	75-06-04	7.6	15.0	330	199	41	12	150
SC01008026BCD	121DRUN	GW	72-08-30	7.8	10.5	321	189	50	7.3	150
SC01008034DCC	111VLFL	GW	72-08-30	7.7	9.0	351	205	44	13	160
SC01008035DBB	121DRUN	GW	72-08-30	8.7	11.0	344	222	43	9.2	150
SC01108010CBD	121DRUN	GW	72-08-30	7.7	10.0	200	142	25	3.6	77

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	BICAR-BONATE (MG/L AS HCO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHORUS, ORTHOPH OSPHATE DISSOL. (MG/L AS P)
				LAKE						
SC00807910DDD	4.4	.2	1.7	22	27	41	2.6	2.9	.29	.000
SC00807932DBD	1.8	.1	1.1	75	91	18	.8	.7	.11	.000
SC00808021ABD	1.9	.1	1.6	31	38	4.2	.3	.1	.07	.010
SC00907906BAD	2.1	.1	1.2	122	149	15	.5	.4	.04	.000
SC00908004AAA	8.5	.5	1.3	46	56	10	18	.0	.59	.020
SC00908009CBA1	5.0	.4	.7	41	50	5.0	.9	.3	.15	.050
SC00908010ACD	27	1.5	1.4	96	117	18	6.8	.5	.37	.020
SC00908012ACA	1.8	.1	1.0	73	89	13	.5	.1	.10	.000
SC00908020DCB	3.8	.2	.9	48	59	21	.6	.2	.16	.030
SC00908021CAA	2.6	.1	1.1	68	83	62	10	.1	.33	.030
SC00908027DAB	21	.4	4.4	113	138	300	20	.1	11	.010
SC00908027DBB	6.0	.2	1.0	103	126	170	11	.1	3.5	.010
SC00908032DAC	3.6	.1	1.5	111	135	83	3.4	.2	.56	.010
SC00908033BAD	11	.2	3.2	39	48	530	23	.1	4.1	.010
SC00908033CCD	3.6	.2	.9	80	98	6.1	1.0	.3	.21	.030
SC00908136ADD	4.9	.4	.9	35	43	7.8	.8	.5	.11	.020
SC01008004BDC	3.6	.2	.9	95	116	4.2	1.6	.1	.52	.020
SC01008005BDC	1.8	.1	1.0	113	138	21	1.4	.2	.31	.000
SC01008008ADC	6.7	.3	4.5	46	56	16	11	.2	5.3	.010
SC01008009ABC	5.4	.2	1.2	112	137	33	3.8	.2	4.6	.020
SC01008026BCD	5.2	.2	.7	154	188	11	1.5	.4	1.4	.050
SC01008034DCC	6.6	.2	1.8	159	194	26	2.5	.3	.07	.010
SC01008035DBB	17	.6	1.8	173	187	20	2.2	.7	.29	.040
SC01108010CBD	11	.5	2.2	95	116	6.9	2.1	.5	.46	.040

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	SILICA, DIS-SOLVED (MG/L AS SIO2)	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)	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	ZINC, DIS-SOLVED (UG/L AS ZN)
			LAKE					
SC00807910DDD	5.3	--	40	--	90	2.2	--	240
SC00807932DBD	4.7	--	40	--	10	--	--	--
SC00808021ABD	13	--	80	--	10	--	--	--
SC00907906BAD	6.3	--	30	--	0	--	--	--
SC00908004AAA	6.3	--	430	--	10	--	--	--
SC00908009CBA1	16	--	40	--	0	--	--	--
SC00908010ACD	18	--	20	--	0	--	--	--
SC00908012ACA	8.3	--	20	--	0	--	--	--
SC00908020DCB	17	--	60	--	0	--	--	--
SC00908021CAA	9.3	--	60	--	0	--	--	--
SC00908027DAB	12	--	30	--	10	--	--	--
SC00908027DBB	15	26	20	7	0	--	--	40
SC00908032DAC	12	--	40	--	0	--	--	--
SC00908033BAD	21	--	120	--	60	--	--	--
SC00908033CCD	16	--	30	--	0	--	--	--
SC00908136ADD	16	--	40	--	30	--	--	--
SC01008004BDC	16	--	80	--	0	--	--	--
SC01008005BDC	6.1	--	90	--	0	--	--	--
SC01008008ADC	14	--	120	--	0	--	--	--
SC01008009ABC	14	--	0	--	0	--	--	--
SC01008026BCD	14	--	20	--	0	.5	--	380
SC01008034DCC	15	--	20	--	0	--	0	130
SC01008035DBB	23	--	40	--	0	--	--	--
SC01108010CBD	31	--	20	7	0	--	--	130

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	GEO-LOGIC UNIT	SITE	DATE OF SAMPLE	PH FIELD (UNITS)	TEMPER-ATURE, WATER (DEG C)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	HARD-NESS (MG/L AS CACO3)
				PUEBLO						
SC01906719DAA	210DKOT	GW	72-09-13	7.5	17.5	724	455	70	30	300
SC01906722BDD	210DKOT	GW	72-09-13	7.7	18.5	3220	2110	10	5.8	49
SC01906727DCD	210DKOT	GW	73-01-24	8.3	4.0	2340	1520	13	5.7	56
SC02006501BBD	217CYNN	GW	73-04-12	7.4	20.0	2850	1850	17	3.3	57
SC02006703BCC	210DKOT	GW	73-03-07	7.2	14.5	3050	2100	42	22	200
SC02006706BAD	210DKOT	GW	73-04-26	6.5	19.0	1900	1280	150	71	670
SC02006714BAC	210DKOT	GW	73-05-26	6.6	18.0	2490	1670	160	86	760
SC02106505ABB2	111VLFL	GW	72-04-11	7.8	13.0	1360	1030	190	48	670
SC02106519ACC	210DKOT	GW	73-03-23	8.3	14.5	2600	1530	61	25	260
SC02106523DAD	210DKOT	GW	73-01-02	6.9	22.5	1870	1320	110	53	490
SC02106530DCD	210DKOT	GW	73-03-20	8.2	16.5	2330	1520	9.0	11	68
SC02106619DBC	210DKOT	GW	73-05-20	6.1	16.0	1680	1070	84	30	340
SC02106625DBB	210DKOT	GW	73-03-12	7.4	14.5	2600	1710	38	19	180
SC02106727DCC	210DKOT	GW	73-04-29	7.1	14.0	1760	1220	80	44	390
SC02106731AAC	221ENRD	GW	73-05-20	7.2	15.0	3680	3130	340	64	1100
SC02106811CCC	210DKOT	GW	72-09-12	6.9	19.0	1640	905	59	20	230
SC02106815CDC	210DKOT	GW	72-09-12	6.6	22.0	3020	1920	140	46	540
SC02206502BCC1	210DKOT	GW	73-03-15	6.9	19.0	1020	683	76	33	330
SC02206520CAA	210DKOT	GW	73-02-27	6.7	19.0	915	631	99	32	380
SC02206521BDD	111VLFL	GW	73-04-23	7.5	8.5	1380	1030	190	48	670
SC02206602CDD	210DKOT	GW	73-03-11	7.0	19.0	1270	853	93	33	370
SC02206607DDC	210DKOT	GW	73-03-29	6.9	19.0	2740	2360	320	130	1300
SC02206610CBB	211FRHS	GW	73-03-11	7.7	13.0	1980	1520	190	83	820
SC02206701ADB	210DKOT	GW	73-04-06	6.9	17.0	2240	1640	74	62	440
SC02206701CAD	111VLFL	GW	73-04-06	7.3	9.5	1120	812	140	30	480
SC02206701DBB	210DKOT	GW	73-04-06	6.7	15.5	1460	1080	150	51	590
SC02206712BAB	210DKOT	GW	73-04-06	6.5	15.5	957	556	74	27	300
SC02206722CCC	210DKOT	GW	73-04-13	5.2	14.5	1230	917	71	110	630
	210DKOT	GW	77-07-07	5.3	14.0	1180	--	--	--	--
SC02206723ACB	210DKOT	GW	73-04-13	5.8	14.0	660	505	73	28	300
SC02206728CAA	217CYNN	GW	73-04-09	7.6	13.0	992	672	120	37	450
SC02206728CAC2	217CYNN	GW	73-04-19	7.3	13.5	718	460	78	26	300
	217CYNN	GW	77-07-07	7.5	13.0	830	--	--	--	--
SC02206730DCB	217CYNN	GW	73-03-19	6.9	11.0	455	290	59	8.7	180
SC02206731ADD	217CYNN	GW	73-01-10	7.6	12.5	1090	761	120	57	540
SC02206731DBA	221MRSN	GW	73-04-19	7.9	14.0	780	503	35	38	240

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	BICAR-BONATE (MG/L AS HCO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHORUS, ORTHOPH OSPHATE DISSOL. (MG/L AS P)
PUEBLO										
SC01906719DAA	42	1.1	5.8	236	288	150	5.1	.8	.00	.000
SC01906722BDD	870	54	3.6	1530	1870	22	260	3.0	.04	.020
SC01906727DCD	560	33	3.6	668	814	470	54	2.2	.02	.020
SC02006501BBD	710	41	4.7	1260	1540	190	150	.4	.23	.020
SC02006703BCC	730	23	8.2	1280	1560	420	96	1.3	.06	.030
SC02006706BAD	220	3.7	23	819	999	230	74	1.0	.09	.010
SC02006714BAC	360	5.7	19	1210	1480	210	84	.3	.02	.010
SC02106505ABB2	63	1.1	6.8	216	263	560	12	.7	1.2	.000
SC02106519ACC	470	13	13	633	772	250	370	1.2	.04	.020
SC02106523DAD	250	4.9	21	376	458	600	37	1.2	.01	.000
SC02106530DCD	570	30	21	1000	1220	240	62	.6	.08	.010
SC02106619DBC	260	6.2	22	579	706	180	120	1.5	.01	.000
SC02106625DBB	620	21	12	1250	1520	170	81	.5	.21	.010
SC02106727DCC	270	6.0	25	498	607	410	67	1.0	.38	.010
SC02106731AAC	570	7.4	22	591	720	1700	49	1.1	.04	.020
SC02106811CCC	290	8.3	17	655	798	94	100	2.4	.00	.030
SC02106815CDC	500	9.4	37	1130	1380	240	240	2.0	.02	.020
SC02206502BCC1	91	2.2	12	235	287	280	16	1.1	.02	.000
SC02206520CAA	44	1.0	5.6	176	214	320	10	.8	.45	.000
SC02206521BDD	63	1.1	4.1	236	288	550	11	.7	.03	.010
SC02206602CDD	140	3.2	10	325	396	350	17	1.1	.08	.000
SC02206607DDC	220	2.6	11	230	280	1500	13	.8	.00	.010
SC02206610CBB	160	2.4	4.3	319	389	830	30	.8	1.6	.010
SC02206701ADB	390	8.1	19	568	692	720	22	1.3	.00	.010
SC02206701CAD	62	1.2	5.3	157	192	450	4.4	.6	1.7	.010
SC02206701DBB	120	2.2	8.6	252	307	560	13	.8	.04	.010
SC02206712BAB	71	1.8	12	295	360	160	17	1.5	.01	.010
SC02206722CCC	15	.3	1.3	7	9	690	3.7	.8	.02	.010
SC02206723ACB	17	.4	3.0	10	12	330	4.4	.4	.01	.010
SC02206728CAA	40	.8	4.4	221	269	300	20	.7	.94	.010
SC02206728CAC2	37	.9	3.9	240	292	140	12	.5	.03	.000
SC02206730DCB	15	.5	2.4	159	194	47	9.4	.2	2.9	.030
SC02206731ADD	43	.8	5.5	308	376	330	5.6	.5	.04	.010
SC02206731DBA	74	2.1	7.0	164	200	240	6.4	.4	.01	.000

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	SILICA, DIS-SOLVED (MG/L AS SIO2)	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)	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	ZINC, DIS-SOLVED (UG/L AS ZN)
			PUEBLO					
SC01906719DAA	10	--	120	--	0	--	--	--
SC01906722BDD	11	--	60	--	20	--	--	--
SC01906727DCD	8.6	--	280	--	20	--	--	230
SC02006501BBD	13	--	1600	--	100	--	--	20
SC02006703BCC	12	1	540	11	30	.0	--	30
SC02006706BAD	11	--	3300	2	70	--	--	30
SC02006714BAC	10	30	5600	0	110	--	--	60
SC02106505ABB2	16	--	90	--	0	--	--	--
SC02106519ACC	6.6	--	1600	--	70	--	--	--
SC02106523DAD	10	--	7100	--	150	--	--	110
SC02106530DCD	5.4	10	40	4	80	--	--	100
SC02106619DBC	10	5	9100	8	150	--	--	70
SC02106625DBB	12	--	7200	--	130	--	--	20
SC02106727DCC	9.3	10	380	3	40	--	--	6600
SC02106731AAC	15	10	50	1	190	--	--	150
SC02106811CCC	20	--	60	--	70	2.2	--	90
SC02106815CDC	29	--	3100	--	200	--	--	--
SC02206502BCC1	7.9	--	22000	--	320	--	--	30
SC02206520CAA	9.0	--	3000	--	200	--	--	--
SC02206521BDD	17	--	30	1	310	--	--	50
SC02206602CDD	8.8	--	1900	4	70	--	--	520
SC02206607DDC	10	--	6600	2	160	--	--	240
SC02206610CBB	19	--	250	--	20	--	--	80
SC02206701ADB	4.9	--	5300	2	130	--	--	100
SC02206701CAD	15	--	20	3	10	--	--	310
SC02206701DBB	9.4	--	9300	5	240	--	--	850
SC02206712BAB	9.3	--	4800	6	320	--	--	270
SC02206722CCC	6.9	--	11000	4	2400	--	0	150
	--	--	--	--	--	--	--	--
SC02206723ACB	11	--	30000	5	1200	--	--	240
SC02206728CAA	12	--	50	3	110	--	--	110
SC02206728CAC2	12	--	3900	4	110	--	--	1400
	--	--	--	--	--	--	--	--
SC02206730DCB	31	120	30	8	20	--	--	8300
SC02206731ADD	11	--	1600	3	60	--	--	310
SC02206731DBA	2.6	--	9	4	210	--	--	20

LOCAL IDENT- I- FIER	GEO- LOGIC UNIT	SITE	DATE OF SAMPLE	PH FIELD (UNITS)	TEMPER- ATURE, WATER (DEG C)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	HARD- NESS (MG/L AS CACO3)
				PUEBLO						
SC02206731DCA	210DKOT	GW	73-03-21	7.3	10.5	371	236	43	7.0	140
SC02206732CBB	221MRSN	GW	73-04-09	7.6	5.5	1270	893	120	62	560
	221MRSN	GW	77-07-06	7.3	17.0	1200	--	--	--	--
SC02206811DDB	221MRSN	GW	73-04-24	8.0	15.0	1120	743	24	6.2	85
SC02206812DCD	210DKOT	GW	73-04-18	7.6	14.0	543	341	66	15	230
SC02206813DAB	221MRSN	GW	73-04-24	7.8	13.0	771	476	43	21	200
SC02306507ACD	210DKOT	GW	73-04-11	7.6	17.0	834	543	84	28	330
SC02306618BCC	221ENRD	GW	73-04-13	7.3	14.0	655	399	75	23	280
SC02306620BAC	211BGCK	GW	73-04-20	6.9	14.0	1980	1740	240	170	1300
SC02306635CCC	210DKOT	GW	73-04-12	7.6	14.0	629	399	32	13	130
SC02306703DCD	210DKOT	GW	73-04-13	7.4	--	1210	831	150	52	590
SC02306706CCB1	217CYNN	GW	73-04-16	7.4	15.5	351	209	41	9.8	140
SC02306707CBD	221MRSN	GW	73-03-29	7.9	14.0	800	497	39	14	160
SC02306707CCB	221MRSN	GW	73-03-29	6.6	15.5	954	642	98	41	410
SC02306713ADA	210DKOT	GW	73-04-13	7.0	7.5	496	300	63	16	220
SC02306722DCD	210DKOT	GW	73-04-19	7.6	13.5	371	216	45	12	160
	210DKOT	GW	77-07-27	7.3	15.0	2650	2240	370	200	1700
SC02306724BBC	217CYNN	GW	73-04-19	7.5	--	1540	1140	200	68	780
SC02306726BBA2	210DKOT	GW	73-03-15	7.1	11.0	4110	3960	390	480	3000
	210DKOT	GW	77-07-08	7.1	14.0	2500	--	--	--	--
SC02306734AAD	210DKOT	GW	73-03-16	7.2	14.0	444	270	54	13	190
SC02306736AAA	211BGCK	GW	73-04-20	8.2	20.5	2640	1820	9.8	5.1	47
SC02306801AAD	210DKOT	GW	73-04-10	7.3	12.0	999	638	110	21	360
SC02306801ADA	210DKOT	GW	73-04-09	7.2	6.0	682	427	82	13	260
	210DKOT	GW	77-07-06	7.7	17.0	680	--	--	--	--
SC02306801CDB	217CYNN	GW	73-04-10	7.1	11.0	502	307	59	9.6	190
	217CYNN	GW	77-07-07	7.5	19.0	530	--	--	--	--
SC02306801DAA	210DKOT	GW	73-04-14	7.3	13.0	404	253	47	13	170
SC02306801DCB	217CYNN	GW	73-04-16	7.1	14.5	339	199	37	11	140
	217CYNN	GW	77-07-07	7.4	15.0	335	--	--	--	--
SC02306802CCC	111VLFL	GW	73-03-29	6.9	4.5	452	277	46	8.2	150
SC02306810BDD	317FNTN	GW	73-04-17	9.2	13.5	2200	1420	4.2	2.2	20
SC02306813BAD	210DKOT	GW	73-04-17	7.8	13.0	598	376	83	6.8	240
SC02306814ADD	210DKOT	GW	73-04-17	7.3	10.5	1620	1160	260	22	740
SC02306821AAC	317FNTN	GW	73-03-28	7.7	13.0	1340	862	25	23	160

LOCAL IDENT- I- FIER	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY (MG/L AS CACO3)	BICAR- BONATE (MG/L AS HCO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	PHOS- PHORUS, OPTHOPH OSPHATE DISSOL. (MG/L AS P)
				PUEBLO						
SC02206731DCA	20	.7	2.7	121	147	43	13	.5	1.4	.010
SC02206732CBB	82	1.5	5.9	313	381	390	25	.6	2.0	.010
	--	--	--	--	--	--	--	--	--	--
SC02206811DDB	220	10	5.1	224	273	330	12	.6	.12	.010
SC02206812DCD	21	.6	2.3	194	237	71	9.2	.6	2.5	.010
SC02206813DAB	93	2.9	5.1	262	319	140	5.5	.7	.03	.000
SC02306507ACD	59	1.4	4.3	242	295	190	19	.9	.03	.000
SC02306618BCC	28	.7	3.0	230	280	110	5.7	.8	1.1	.010
SC02306620BAC	33	.4	4.2	229	279	1100	5.9	.4	.02	.000
SC02306635CCC	93	3.5	4.5	253	308	87	3.0	.7	.01	.000
SC02306703DCD	60	1.1	5.0	381	464	320	3.1	.4	.00	.010
SC02306706CCB1	16	.6	2.3	148	180	28	4.8	.8	.01	.000
SC02306707CBD	120	4.2	4.8	281	342	130	4.0	.8	1.1	.010
SC02306707CCB	52	1.1	5.0	326	397	200	2.6	.5	.04	.010
SC02306713ADA	19	.6	2.1	199	243	57	5.5	.9	1.4	.310
SC02306722DCD	13	.4	2.4	159	194	30	3.0	.4	.06	.000
	46	.5	4.9	300	370	1400	21	.3	--	--
SC02306724BBC	63	1.0	4.5	267	325	590	35	.6	1.9	.010
SC02306726BBA2	76	.6	5.3	345	421	2700	29	1.0	12	.020
	--	--	--	--	--	--	--	--	--	--
SC02306734AAD	19	.6	3.0	194	237	48	2.2	.5	.04	.020
SC02306736AAA	640	41	5.0	902	1100	590	17	1.4	.00	.010
SC02306801AAD	57	1.3	2.3	221	270	83	69	.3	30	.040
SC02306801ADA	42	1.1	1.9	253	309	65	23	.7	4.9	.020
	--	--	--	--	--	--	--	--	--	--
SC02306801CDB	28	.9	2.2	183	223	40	20	.7	2.4	.100
	--	--	--	--	--	--	--	--	--	--
SC02306801DAA	14	.5	2.9	139	170	72	5.0	.6	.05	.010
SC02306801DCB	14	.5	3.5	137	167	33	3.4	.8	.07	.020
	--	--	--	--	--	--	--	--	--	--
SC02306802CCC	31	1.1	4.1	145	177	47	15	.7	3.8	.150
SC02306810BDD	530	52	3.2	762	929	300	100	6.6	.02	.010
SC02306813BAD	38	1.1	1.8	244	297	64	13	.6	.55	.010
SC02306814ADD	79	1.3	5.5	356	434	390	61	.5	24	.010
SC02306821AAC	270	9.4	5.7	520	634	180	18	7.8	.01	.010
SC02306824BBD	22	.5	4.1	290	354	110	4.2	.4	5.8	.010

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	SILICA, DIS-SOLVED (MG/L AS SIO2)	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)	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	ZINC, DIS-SOLVED (UG/L AS ZN)
			PUEBLO					
SC02206731DCA	28	--	30	--	20	--	--	90
SC02206732CBB	9.6	--	30	3	10	--	--	440
	--	--	--	--	--	--	--	--
SC02206811DDB	10	--	70	--	10	--	--	--
SC02206812DCD	25	--	9	2	20	--	--	2200
SC02206813DAB	8.8	9	50	1	20	--	--	450
SC02306507ACD	9.2	--	1400	3	130	--	--	170
SC02306618BCC	10	--	30	2	10	--	2	40
SC02306620BAC	12	--	28000	4	2000	--	--	1800
SC02306635CCC	9.1	--	4400	4	220	--	--	240
SC02306703DCD	9.2	--	90	5	20	--	0	1400
SC02306706CCB1	14	--	1900	13	870	--	--	320
SC02306707CBD	9.8	--	50	3	10	--	--	270
SC02306707CCB	3.5	--	34000	2	710	--	--	2300
SC02306713ADA	10	--	60	3	30	--	2	190
SC02306722DCD	8.9	--	4400	6	110	--	--	300
	16	--	190	--	170	--	--	--
SC02306724BBC	13	--	50	3	390	--	--	160
SC02306726BBA2	16	20	550	3	2000	--	22	340
	--	--	--	--	--	--	--	--
SC02306734AAD	9.4	--	2800	--	90	--	--	290
SC02306736AAA	10	--	600	5	30	--	--	200
SC02306801AAD	26	--	80	3	20	--	--	2500
SC02306801ADA	23	--	40	3	20	--	--	1800
	--	--	--	--	--	--	--	--
SC02306801CDB	26	--	40	3	10	--	--	620
	--	--	--	--	--	--	--	--
SC02306801DAA	12	--	1600	5	510	--	--	200
SC02306801DCB	13	11	690	4	120	--	0	50
	--	--	--	--	--	--	--	--
SC02306802CCC	20	--	30	2	0	--	--	400
SC02306810BDD	13	--	370	6	20	--	--	30
SC02306813BAD	19	--	90	--	320	--	--	--
SC02306814ADD	19	--	130	5	30	--	24	360
SC02306821AAC	19	--	210	3	80	--	--	20
SC02306824BBD	13	18	1000	6	170	--	2	130

LOCAL IDENT- I- FIER	GEO- LOGIC UNIT	SITE	DATE OF SAMPLE	PH FIELD (UNITS)	TEMPER- ATURE, WATER (DEG C)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	HARD- NESS (MG/L AS CACO3)
				PUEBLO						
SC02306824BDC	210DKOT	GW	73-04-17	7.5	16.5	761	471	93	33	370
SC02306824DAD	210DKOT	GW	73-04-16	7.6	12.0	1270	876	180	26	560
SC02406619CDA	210DKOT	GW	73-03-13	7.6	14.5	551	324	77	13	250
SC02406620BBB	210DKOT	GW	73-03-10	7.3	--	526	315	60	15	210
SC02406620CAD	210DKOT	GW	73-02-23	8.5	14.0	217	126	5.0	2.7	24
SC02406621BAC	111AVMT	GW	73-03-13	7.5	12.0	1540	1160	240	48	800
SC02406701CDA	211FRHS	GW	73-03-16	6.9	13.5	2500	2080	400	110	1500
SC02406701DBC	210DKOT	GW	73-03-16	7.3	15.0	453	270	53	13	190
SC02406702ABD	211FRHS	GW	73-04-19	7.6	11.5	793	506	90	23	320
SC02406702DBB	210DKOT	GW	73-04-20	7.2	19.0	595	372	75	16	250
SC02406712ACC	210DKOT	GW	73-03-16	7.3	16.0	531	321	63	14	220
SC02406721ACB	210DKOT	GW	73-05-05	7.4	12.0	299	177	34	9.8	130
SC02406727CBC	210DKOT	SP	73-03-14	7.3	10.0	416	261	53	8.4	170
SC02406729DDC	210DKOT	GW	73-04-23	7.6	8.0	383	237	43	8.8	140
SC02406730CAC	210DKOT	GW	73-02-23	7.0	12.0	581	366	82	10	250
SC02406731BBC	210DKOT	GW	73-02-23	7.6	14.5	383	232	48	7.2	150
SC02406732AAA	211CDLL	GW	73-04-12	7.4	10.0	599	377	77	11	240
SC02406732AAB	210DKOT	GW	73-04-12	6.9	13.0	399	248	45	9.2	150
SC02406733ACB	111AVMT	GW	73-03-14	7.2	9.5	1400	1040	230	42	750
SC02406736BCD	221MRSN	GW	73-04-23	4.6	13.0	2020	1830	290	110	1200
SC02406823BAA	210DKOT	GW	73-05-05	7.4	9.0	481	289	55	11	180
SC02506705BBA	112TERC	GW	73-02-24	7.4	12.0	444	279	55	11	180
SC02506711AAA	210DKOT	GW	73-04-23	7.7	14.0	1450	874	11	3.1	41

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT- I- FIER	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY (MG/L AS CACO3)	BICAR- BONATE (MG/L AS HCO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	NITPO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	PHOS- PHORUS, ORTHOPH OSPHATE DISSOL. (MG/L AS P)
PUEBLO										
SC02306824BDC	20	.5	4.2	306	373	120	5.5	.2	.04	.010
SC02306824DAD	68	1.3	5.0	326	397	300	33	.7	12	.010
SC02406619CDA	19	.5	2.6	218	266	61	4.0	.6	.04	.010
SC02406620BBB	30	.9	3.4	231	282	48	4.3	.7	.52	.010
SC02406620CAD	31	2.8	3.7	53	65	40	8.5	.6	.38	.010
SC02406621BAC	54	.8	4.7	259	316	600	23	.3	1.7	.050
SC02406701CDA	85	1.0	5.1	490	598	1100	17	.6	7.1	.010
SC02406701DBC	22	.7	3.2	202	246	42	2.0	.6	.04	.000
SC02406702ABD	49	1.2	2.9	308	375	130	4.8	.5	.21	.010
SC02406702DBB	25	.7	3.3	222	271	96	3.3	.4	.02	.000
SC02406712ACC	29	.9	3.4	228	278	55	3.7	.6	.06	.010
SC02406721ACB	7.6	.3	11	146	178	9.7	4.8	.1	.20	.030
SC02406727CBC	19	.6	1.8	163	199	54	4.2	.4	.55	.050
SC02406729DDC	21	.8	2.4	126	153	69	4.1	.3	.04	.000
SC02406730CAC	21	.6	2.0	171	209	120	3.7	.2	2.0	.010
SC02406731BBC	20	.7	2.2	166	202	34	3.2	.4	.13	.010
SC02406732AAA	42	1.2	1.6	264	322	50	7.9	.6	.91	.030
SC02406732AAB	22	.8	2.4	136	166	63	3.3	.4	.01	.010
SC02406733ACB	27	.4	2.8	276	337	540	4.1	.4	.62	.030
SC02406736BCD	39	.5	6.0	0	0	1300	11	1.4	.02	.010
SC02406823BAA	34	1.1	.8	239	291	16	3.8	.2	.63	.050
SC02506705BBA	23	.7	1.1	193	235	26	5.7	.6	3.6	.020
SC02506711AAA	340	23	4.0	796	970	5.0	19	2.1	.01	.020

WATER-QUALITY DATA FOR WATER FROM WELLS AND SPRINGS--Continued

LOCAL IDENT-I-FIER	SILICA, DIS-SOLVED (MG/L AS SIO2)	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)	MERCURY DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	ZINC, DIS-SOLVED (UG/L AS ZN)
PUEBLO								
SC02306824BDC	9.9	--	140	--	1000	--	--	--
SC02306824DAD	13	--	50	5	--	--	28	--
SC02406619CDA	14	5	510	3	170	.1	--	60
SC02406620BBB	8.0	5	3500	5	170	--	--	130
SC02406620CAD	.5	--	50	--	0	--	--	--
SC02406621BAC	23	--	70	--	20	--	--	80
SC02406701CDA	23	--	340	--	60	--	--	200
SC02406701DBC	9.4	--	1900	--	80	--	--	570
SC02406702ABD	18	--	100	6	0	--	--	150
SC02406702DBB	10	--	3300	4	200	--	--	5000
SC02406712ACC	8.6	6	5900	3	200	--	110	20
SC02406721ACB	9.9	10	9	6	480	--	--	100
SC02406727CBC	19	--	20	--	10	--	--	10
SC02406729DDC	11	--	1100	4	110	--	--	110
SC02406730CAC	14	8	50	5	30	--	--	150
SC02406731BBC	13	5	3200	10	140	--	--	140
SC02406732AAA	23	90	40	3	10	--	2	820
SC02406732AAB	9.7	--	9900	3	310	--	0	380
SC02406733ACB	25	--	50	--	10	--	--	20
SC02406736BCD	16	--	22000	22	180	--	--	36000
SC02406823BAA	21	30	30	6	0	--	--	200
SC02506705BBA	25	--	30	--	10	--	--	--
SC02506711AAA	10	--	150	4	20	--	--	900