Hydrogeologic and Geophysical Data for Selected Wells and Springs in the Sheep Range Area, Clark and Lincoln Counties, Nevada

By Donald H. Schaefer[1], Thomas M. Morris[2], and Michael D. Dettinger[1]

[1] U.S. Geological Survey
[2] Desert Research Institute, University of Nevada

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MANUEL LUJAN, JR., *Secretary*

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Dallas L. Peck, *Director*

For additional information write to:

U.S. Geological Survey
333 West Nye Lane
Carson City, NV 89706

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CONVERSION FACTORS AND ABBREVIATIONS

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

Multiply	By	To obtain
Cubic feet per second (ft^3/s)	0.02832	Cubic meter per second (m^3/s)
Foot (ft)	0.3048	Meter (m)
Gallon (gal)	3.785	Liter (L)
Gallon per min (gal/min)	0.06309	Liter per second (L/s)
Inch (in.)	25.40	Millimeter (mm)
Mile (mi)	1.609	Kilometer (km)
Square mile (mi^2)	2.590	Square kilometer (km^2)

For temperature, degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) by using the formula °F = [(1.8)(°C)] + 32.

SEA LEVEL

In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929), which is derived from a general adjustment of the first-order leveling networks of both the United States and Canada (formerly called "Sea-Level Datum of 1929").

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ABSTRACT

Hydrogeologic and geophysical data were collected for six wells and nine springs in the Sheep Range area, southern Nevada. Data collected for the wells include records of drilling operations, lithologic logs, geophysical logs, results of water-quality analyses, water-level measurements, and aquifer-test data. Data for the springs include field locations, flow measurements, and results of water-quality analyses.

The five wells that were drilled as part of the Nevada Carbonate Aquifers Program (NCAP) range in depth from 420 to 1,403 feet. All but one of the wells penetrate carbonate rock. Water levels ranged from 158 to 1,330 feet below land surface. Chemical quality of the water from the three sampled wells was similar, and specific conductance averaged about 380 µs/cm (microsiemens per centimeter at 25°C).

The springs were field located and their flow measured also as part of the NCAP. Flows from the springs varied from a low of 0.00027 cubic foot per second to a high of about 0.27 cubic foot per second. Specific conductance of the spring flows varied from 320 to 740 µs/cm.

INTRODUCTION

In 1985, the U.S. Geological Survey and the Desert Research Institute began investigating the geology and hydrology in southern Nevada to better understand the regional carbonate-rock aquifer systems. This study, known as the Nevada Carbonate Aquifers Program (NCAP), was done in cooperation with the State of Nevada, the Las Vegas Valley Water District, and the U.S. Bureau of Reclamation.

The wells and springs described in this report are in an area encompassing approximately 1,300 mi^2 that includes the Desert Range, Sheep Range, and an unnamed, intervening basin (figure 1). The study area is within the southern part of the Basin and Range Province, about 50 miles north of Las Vegas, Nev. In the study area, basin-fill sedimentary deposits of Tertiary age and alluvial deposits of Quaternary age overlie thick units of carbonate rock of Paleozoic age. Five of the six wells described in this report are completed in carbonate rock and all nine springs issue from carbonate rock.

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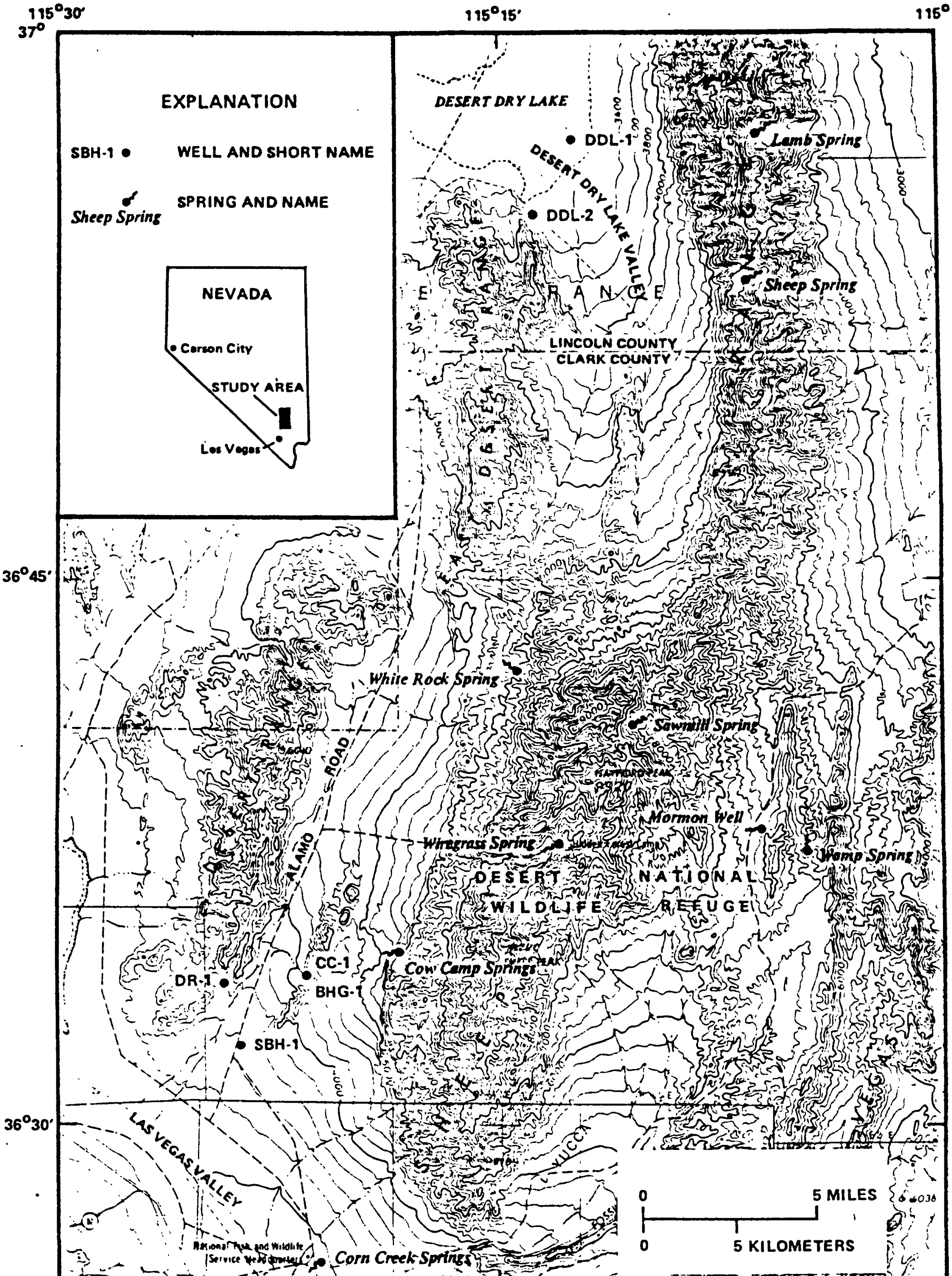
[1] U.S. Geological Survey
[2] Desert Research Institute, University of Nevada



Base from U.S. Geological Survey
Las Vegas 1:250,000, 1954

FIGURE 1.--Location of wells and springs in study area.

As part of the NCAP exploration plan, five wells were drilled and a sixth, existing well was cleaned out. Geophysical, lithologic, hydrologic, and geochemical data collected from the six wells are presented in this report. Three of the wells were drilled by the Geological Survey in 1987 and 1989, one well was drilled by the U.S. Bureau of Reclamation in 1987, and one was constructed by a commercial driller in 1988 and cleaned out and cased by the Geological Survey in 1989. The sixth well was drilled as a stock well in about the 1950's and was cleaned out by the Geological Survey in 1986. Figure 1 shows the location of the wells and table 1 gives other information about the wells.

Also as part of the NCAP, nine springs were visited periodically to measure flows and sample for chemical analysis. Wiregrass Spring (figure 1) was sampled several times during 1987-88 to ascertain whether the chemical character of the springflow changed with time. Figure 1 shows the location of the nine springs.

TABLE 1.--*Locations, water levels, and other information for wells*

[Abbreviations: DRI, Desert Research Institute, University of Nevada; USGS, U.S. Geological Survey]

Short site name (fig. 1)[1]	Local site identification[1]	Latitude (degrees, minutes, seconds)	Longitude[1] (degrees, minutes, seconds)	Land-surface altitude (feet above sea level)	Well depth (feet below land surface)	Water level: Date	Water level: Feet below land surface	Water level: Source of measurement
SBH-1	212 S16 E58 23DDD	36 32 12	115 24 03	3,475	720	02-25-87	581.81	USGS
						05-05-87	580	USGS
						08-04-87	581.1	USGS
						05-17-88	580.95	USGS
						11-29-88	580.85	USGS
BHG-1	212 S16 E59 08CC1	36 34 06	115 21 53	4,187	430	02-18-87	Dry	USGS
DDL-2	169B S12 E60 10AD	36 55 02	115 13 41	3,250	460	02-05-89	216.07	USGS
CC-1	212 S16 E59 08CC2	36 34 07	115 21 53	4,187	1,403	08-27-87	1,335.1	USGS
						09-22-87	1,334.4	DRI
						03-10-88	1,333.6	DRI
						08-10-88	1,338.8	DRI
DDL-1	169B S11 E60 36AA	36 57 11	115 11 52	3,208	420	10-01-86	159.60	USGS
						05-06-87	161	USGS
						09-13-87	158.44	USGS
						05-17-88	158.38	USGS
DR-1	212 S16 E58 14A	36 33 32	115 24 40	3,579	930	02-02-89	815.37	USGS
						02-03-89	815.49	USGS

[1] In this table, each well is identified by a short site name, the local (Nevada) site-identification system, and by latitude and longitude. In most of this report, the short name (for example SBH-1) is used, for convenience. The local site-identification system is based on an index of hydrographic areas in Nevada (Rush, 1968) and on the rectangular subdivision of the public lands referenced to the Mount Diablo base line and meridian. Each number consists of four units separated by spaces: The first unit is the hydrographic area number. The second unit is the township, preceded by an N or S to indicate location north or south of the base line. The third unit is the range, preceded by an E to indicate location east of the meridian. The fourth unit consists of the section number and letters designating the quarter section, quarter-quarter section, and so on (A, B, C, and D indicate the northeast, northwest, southwest, and southeast quarters, respectively), followed by a number indicating the sequence in which the well was recorded if more than one well exists with the same series of letters. The more letters following the section number, the more accurately the well has been located. As an example, well 169B S11 E60 36AA is in the southern part of the Tikapoo Valley (hydrographic area 169B). It is the first (and only well, hence no sequence number) recorded in the northeast quarter of the northeast quarter of section 36, Township 11 South, Range 60 East, Mount Diablo base line and meridian.

DATA FOR WELLS

Drilling Operations

U.S. Geological Survey Test Wells

The Geological Survey drilled three test wells in the area immediately west of the Sheep Range: South Black Hills No. 1 (SBH-1), Cow Camp Pilot Hole (BHG-1), and Desert Dry Lake No. 2 (DDL-2). In addition, the Survey cleaned out or renovated two other wells: Desert Range No. 1 (DR-1) and Desert Dry Lake No. 1 (DDL-1). All these wells are on land that is under the jurisdiction of the U.S. Fish and Wildlife Service in the National Desert Wildlife Refuge. Figure 1 shows the location of the wells and table 2 summarizes information on drilling and construction.

Lithologic samples from the wells, in the form of drill cuttings, generally were taken at 10-foot intervals or wherever there was a major change in lithology. Lithologic logs constructed from these samples are presented for four of the wells. Whenever possible, lithium bromide was added to the drilling fluid so that when water samples for chemical analyses were taken, contamination of the sample by the drilling fluid could be detected.

TABLE 2.--*Summary of drilling and construction information for wells*

Short site name	Drilled interval (feet below land surface)	Date drilled	Bit diameter (inches)	Casing			Drilling fluid
				Length (feet)	Diameter (inches)	Type	
SBH-1	0-50 0-720	02-24-87	9.88 7.88	0-720	6.0	PVC[1]	Air foam
BHG-1	0-430	02-18-87	7.88	0-60	6.0	PVC	Air foam
DDL-2	0-14 0-460	01-21-89	12.00 5.88	0-13	10.0	Steel	Air foam
CC-1	0-20 0-217 0-378 0-1,403	08-04-87	20.0 9.88 12.0 5.88	0-20 0-378 0-1,390	14.0 8.0 4.0	Steel Steel Steel	Freshwater bentonite mud Air foam
DDL-1	0-420	10-01-86[2]	4.88	0-150	5.5	Steel	Air foam
DR-1	0-182 0-960	01-26-89	17.0 9.88	0-182 0-930	10.0 8.0	Steel Steel	Freshwater bentonite mud Air foam

[1] PVC, polyvinyl chloride.

[2] Clean-out completed; original drill date unknown.

South Black Hills No. 1 (SBH-1)

Well SBH-1 is in northwest Las Vegas Valley and is approximately 7 miles north of the Corn Creek Ranger Station of the Desert National Wildlife Refuge. The well site is about 150 feet east of Alamo Road (figure 1).

Work began on Well SBH-1 on February 19, 1987. Drilling was started using a 9-7/8-inch tricone bit and air foam as a drilling fluid. The drilling fluid contained a lithium bromide solution of about 20 mg/L (milligrams per liter). Drilling continued with this bit size to a depth of 50 feet. At that time the bit was changed to a 7-7/8-inch tricone. Micritic limestone was penetrated at about 60 feet (table 3). Drilling continued to a depth of 720 feet below land surface. At this depth, fractures and caving conditions in the hole made it advisable to cease drilling.

Because of the generally broken-up and fractured condition of the rocks surrounding the hole, 6-inch diameter PVC (polyvinyl chloride) casing was installed. A total of 720 feet of casing was lowered into the well with a 30-foot section from 665 to 695 feet screened with 0.004-inch slotted PVC casing. Once the casing was set in place, the upper 50 feet of casing was cemented.

The well was completed on February 24, 1987, and a depth to water of 581.81 feet below land surface was measured on February 25, 1987.

TABLE 3.--*Lithologic log for well SBH-1*

Depth (feet)	Thickness (feet)	Lithology
0-60	60	Limestone pebble gravels.
60-180	120	Medium gray to buff micritic limestone with traces of white calcite veins and occasional yellow to rose oxidized lenses.
180-200	20	Medium gray to buff, fine grained sparry dolomite.
200-330	130	Medium gray, fine grained sparry limestone with calcite-filled microfractures and shaley micritic limestone at 260-290 feet.
330-400	70	Interbedded buff to yellow or rosy micritic dolomite and medium gray micritic dolomite with some white calcite veins.
400-620	220	Medium gray, fine to medium grained sparry dolomite with traces of chert and white calcite veins.
620-720	100	Medium to dark gray, fine to medium grained sparry dolomite with abundant white dolomite veins.

Cow Camp Pilot Hole (BHG-1)

Well BHG-1 is in northwest Las Vegas Valley and is approximately 9 miles north of the Corn Creek Ranger Station of the Desert National Wildlife Refuge. The well site is on a dirt road approximately 1.6 miles east of the Alamo Road (figure 1).

In preparation for the drilling of the deep (planned depth, 2,500 feet) Cow Camp well, a pilot hole was drilled near the planned site. The purpose of the pilot hole was to determine depth to bedrock before the deep hole was drilled. If limestone bedrock had been penetrated at a depth much greater than about 400 feet in the pilot hole, a new site for the Cow Camp well would have been chosen because of the limitations of the drilling rig.

Drilling began on the pilot hole on February 18, 1987, using a 7-7/8-inch tricone bit and air foam as the drilling fluid. Bedrock was penetrated about 400 feet below land surface. Drilling continued into the limestone until a depth of 430 feet was reached. The hole was completed on February 19, 1987. Ground water was not detected, and the hole was later destroyed during the construction of the Cow Camp well.

Desert Dry Lake No. 2 (DDL-2)

Well DDL-2 is at the south end of Desert Dry Lake Valley, on the east side of the East Desert Range (figure 1).

Drilling began on Well DDL-2 on January 19, 1989, using a 9-3/8-inch tricone bit and air foam as a drilling fluid. A lithium bromide solution with a concentration of about 20 mg/L was added to the drilling fluid. Limestone was penetrated about 6 feet below land surface (table 4), and drilling continued to a depth of about 14 feet. A 12-inch bit was put on and the hole reamed to the bottom. A total of 16 feet of 10-inch steel casing was installed, but the casing could only be set at 13 feet below land surface due to tight conditions near the bottom. Drilling continued into the limestone using a 5-7/8-inch percussion-hammer bit. A total depth of 460 feet below land surface was reached on January 20 and the hole was cleaned out on January 21, 1989.

Drilling conditions associated with materials penetrated during the construction of DDL-2 were generally good. No major fractures were found and no squeezing silt zones were encountered. Because of the generally strong nature of the borehole walls, the hole was not cased in the limestone. Ground water was found in the hole at about 200 feet below land surface. Once drilling was completed, the water level was about 216 feet below land surface.

TABLE 4.--*Lithologic log for well DDL-2*

Depth (feet)	Thickness (feet)	Lithology
0-6	6	Basin-fill material.
6-130	124	Medium gray micritic limestone. Some chert, calcite, limonite, and buff to neutral siltstone. Fractures in limestone platy chips.
130-150	20	Medium gray micritic limestone with common (20 percent) smoky chert. Minor hematite, limonite, and calcite.
150-210	60	Medium gray micritic limestone with traces of limonite, calcite, and buff siltstone.
210-280	70	Medium gray micritic limestone with common (20 percent) buff siltstone. Traces of limonite, calcite, and dark gray limestone.
280-320	40	Medium gray micritic limestone with traces of buff siltstone, limonite, calcite, and hematite.
320-340	20	Medium gray micritic limestone with 30 percent smoky chert and 20 percent limonite-stained siltstone.
340-360	20	Medium gray micritic limestone.
360-460	100	Medium gray micritic limestone with traces of hematitic sandstone, limonitic siltstone, and calcite veins.

Other Wells

A total of three wells in the area either already existed when the project began or were drilled by some agency or organization other than the Geological Survey. Two of these wells were cleaned out by the Geological Survey to make them accessible.

Lithologic samples were collected during the construction of these wells whenever possible, using the same protocol previously described. Whenever possible, the drilling fluid also was tagged with lithium bromide.

Cow Camp Well (CC-1)

Well CC-1 is approximately 55 feet northeast of well BHG-1, the pilot hole. The U.S. Bureau of Reclamation began drilling on April 14, 1987. Shale and limestone were penetrated 142 feet below land surface (table 5). The water table was reached approximately 1,334 feet below land surface. Drilling continued through limestone and dolomite sections, attaining a total depth of 1,403 feet on August 4, 1987. The carbonate rocks revealed little fracturing, although several solution voids were found above the water table. Eight-inch-diameter steel casing was cemented into place from land surface to 378 feet, and 4-inch-diameter steel casing was sleeved from land surface to 1,390 feet. During installation, the 4-inch casing was sheared and bent at approximately 1,355 feet below land surface. Hence, access into the well below this depth is difficult.

TABLE 5.--*Lithologic log for well CC-1*

Depth (feet)	Thickness (feet)	Lithology
0-142	142	Alluvium, gravel (75 percent), coarse to fine sand (20 percent), silt, and clay (5 percent). Contains poorly sorted, angular limestone clasts.
142-349	207	Shale and limestone. Shale (60 percent): tan, brown, and green. Limestone (40 percent): dark to medium gray shaley/silty, some fine grained, with white calcite stringers.
349-800	451	Dolomite, fine grained, some medium to coarse grained, light to dark gray, yellowish tan, and pink and white; small interbeds of limestone, medium gray to black. Some unconsolidated brecciated zones with angular clasts in red and yellow fine sand, silt and clay. A few small lenses of solid white calcite.
800-1,201	401	Limestone and dolomite. Limestone (65 percent): fine grained, medium to dark gray. Dolomite (35 percent): fine grained, light to dark gray; one small tan calcarious shale lens. Some solution voids.
1,201-1,381	180	Breccia, dolomite, and limestone. Breccia: fine to coarse grained, moderately cemented, angular clasts, white and gray. Dolomite: fine grained, medium to dark gray. Limestone: fine grained, medium to dark gray, small lenses of white calcite.
1,381-1,403	22	Shale and dolomite. Shale: silty, rusty brown. Dolomite: fine grained, medium to dark gray, limey.

Desert Dry Lake No. 1 (DDL-1)

Well DDL-1 is on the southeastern edge of the playa in Desert Dry Lake Valley (figure 1). This well probably was drilled during the 1950's to provide water for livestock. When NCAP began, the well was obstructed by a windmill pump rod that prevented a water-level measurement. Renovation of the well started September 30, 1986, by removing about 175 feet of "jack-pump" pipe from the well.

Drilling began using a 4-7/8-inch bit and air foam as a drilling fluid. The fluid was tagged with a 20-mg/L concentration of lithium bromide. No cuttings were returned from the hole until about 230 feet below land surface, when some fine sand and silt emerged. Drilling continued to a depth of 420 feet below land surface on October 1, 1986. The water level was 159.60 feet below land surface on that date. This well penetrates only basin-fill deposits, but until DDL-2 was drilled, DDL-1 was the only well within about 20 miles of Desert Dry Lake.

Desert Range No. 1 (DR-1)

Well DR-1 is at the south end of the Desert Range, approximately 9 miles north of Corn Creek Springs. The well site is 1 mile west of the Alamo Road (figure 1).

Russell Drilling Company of Billings, Mont., began the drilling on July 4, 1988. Limestone was penetrated at 138 feet below land surface (table 6), and the water table was reached at approximately 815 feet. The well was cased with 10-inch-diameter steel casing that was pressure-cemented into place. Intermittent drilling continued through the limestone and dolomite sections until September 10, when the drill tools became stuck in the hole at 957 feet. Efforts to clear the borehole of the bit and drill string were not successful until October 9, 1988.

The Geological Survey reamed and cleaned the hole to a total depth of 960 feet on January 7, 1989. The limestone was moderately fractured, although no substantial loss of drilling-fluid circulation occurred, apparently because the fracture voids were filled with fine sand, silt, and clay. Eight-inch-diameter steel casing, with 60 feet of perforations at the bottom, was sleeved to 930 feet. During the installation of this casing, a drill bit was lost at the bottom of the hole.

Table 6.--***Lithologic log for well DR-1***

Depth (feet)	Thickness (feet)	Lithology
0-87	87	Alluvium, gravel (75 percent), coarse sand (20 percent), silt and clay (5 percent). Contains poorly sorted angular limestone clasts.
87-130	43	Alluvium, red and orange; medium to fine sand and silt (30 percent); and gravel (70 percent).
130-138	8	Lake silts and clay, red and orange medium to fine sand, silt, and clay.
138-404	266	Limestone, fine grained, gray to dark gray with shades of brown and tan. Fracture voids filled with red and orange fine sand, silt, and clay.
404-522	118	Limestone, fine grained, gray to dark gray with shades of brown, some minor greenish-gray dolomite beds. Faulted; seven imbricate fault planes filled with orange and red fine sand, silt, and angular limestone clasts.
522-563	41	Limestone, fine to medium grained, gray to dark gray. Fractured, silt-filled.
563-627	64	Shale and silty dolomite, medium to coarse grained sandy dolomite, brown to gray. Beds of brownish-green shale. Small lenses of sandy gray limestone.
627-960	333	Dolomite, fine grained, alternating light and dark gray, shades of light tan. Occasional black, fine grained limestone lenses.

Lithologic Logs

Lithologic logs were obtained for the wells drilled by the U.S. Geological Survey by collecting drill cuttings while holes were being drilled. The cuttings were usually collected at the point where the drilling fluid returns to the surface. When a shaker table was used to remove cuttings from the drilling fluid, the samples were collected from the shaker table. If air foam was used as the drilling fluid, cuttings from the borehole were collected under an apron on the drilling rig.

Samples were usually collected continuously during drilling. These were analyzed on the site, and some samples were kept and stored. During some of the drilling operations, cuttings were collected at 10- or 20-foot intervals. Samples also were collected where any major change in lithology was detected.

Lithologic logs for wells SBH-1, DDL-2, CC-1, and DR-1 are presented in tables 3, 4, 5, and 6, respectively. No log is available for BHG-1 because this hole was drilled solely to determine depth to consolidated rock at the Cow Camp drill site, and no log could be found for existing well DDL-1.

Geophysical Logs

Geophysical logs were run in all six of the wells in the study area by either the Borehole Services Unit (BSU) of the Geological Survey in Denver, Colo., or by the Drilling Unit (DU) of the Geological Survey in Santa Barbara, Calif. Both units ran similar geophysical logs in SBH-1.

The logs most frequently made were caliper and natural gamma. Logging done by the BSU usually included temperature and radiation (neutron and gamma-gamma) because they had the necessary specialized equipment. Logs run by DU often included spontaneous potential and single-point resistivity because the logging rig was at the site upon completion of the hole while drilling fluid was still in place.

Table 7 shows which geophysical logs are available for the six wells; the logs included in this report are shown in figure 2. Some logs--temperature and neutron logs, for example--are shown for only the saturated interval, because measurements from a water-filled hole are required for analysis.

TABLE 7.--***Summary of geophysical well logs***

[USGS, U.S. Geological Survey; logs are in figure 2; asterisk (*) indicates geophysical log available but not presented in this report]

Short site name	Date logged	Source	Type of log	Logged interval (feet below land surface)
SBH-1	02-24-87	USGS, Santa Barbara	Natural gamma*	0-695
			Caliper*	0-695
			Spontaneous potential*	578-694
			Single-point resistivity*	578-694
	05-05-87	USGS, Denver	Natural gamma	0-694
			Fluid log	581-694
			Gamma-gamma density	0-694
			Neutron	400-694
BHG-1	05-04-87	USGS, Denver	Natural gamma	0-427
			Gamma-gamma density	0-426
			Caliper	0-426
DDL-2	01-21-89	USGS, Santa Barbara	Caliper	0-461
			Natural gamma	0-461
			Spontaneous potential	216-461
			Single point resistivity*	216-461
			Long normal	216-461
CC-1	05-27-87	USGS, Denver	Natural gamma	0-375
			Caliper	0-375
			Gamma-gamma density	0-374
DDL-1	05-06-87	USGS, Denver	Temperature*	161-280
			Natural gamma	0-275
			Caliper	0-277
DR-1	01-08-89	USGS, Santa Barbara	Caliper*	0-814
	01-11-89	USGS, Santa Barbara	Caliper*	0-682
			Natural gamma*	0-682

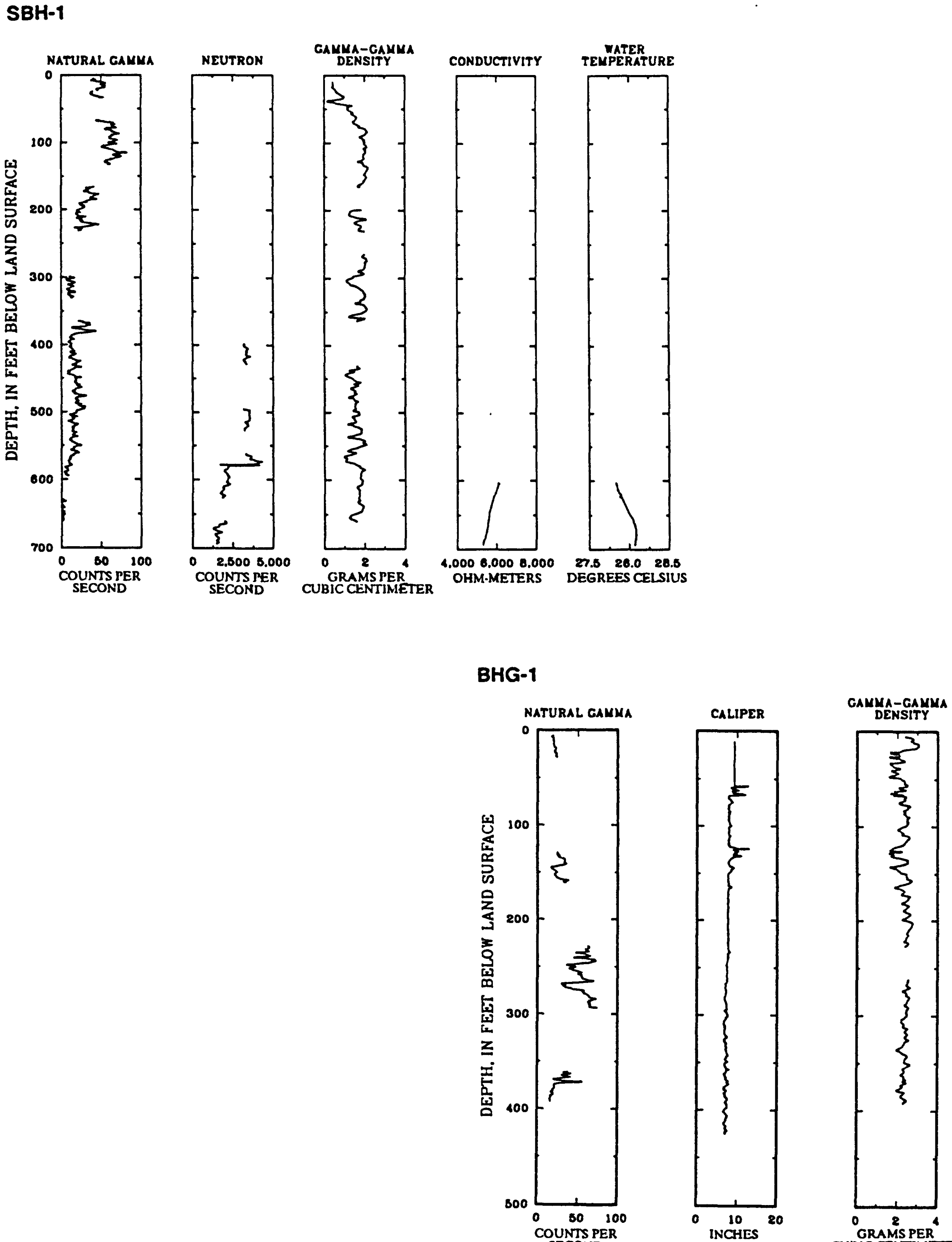


FIGURE 2.--Geophysical logs for wells.

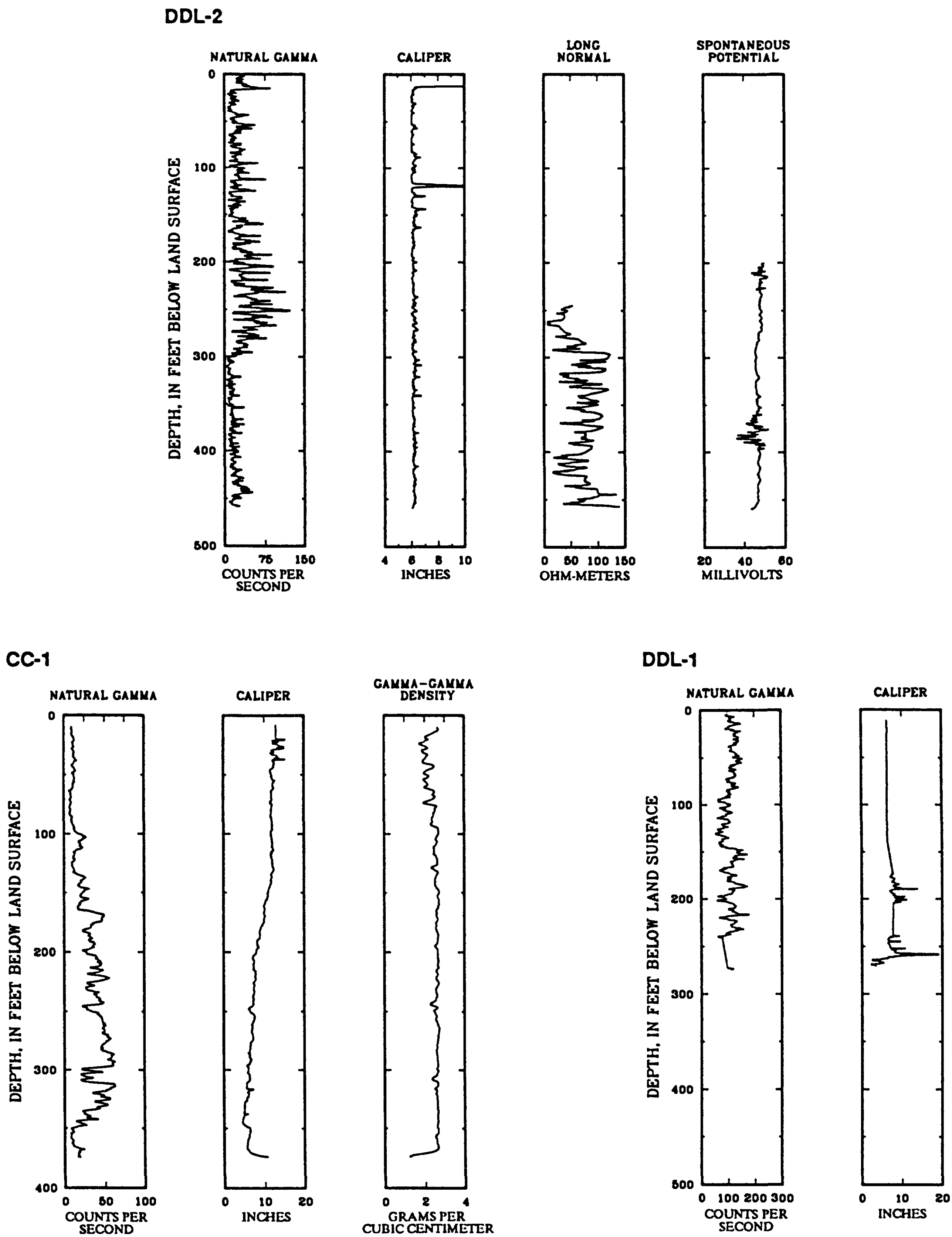


FIGURE 2.--Continued.

Water-Quality Analyses

Water samples were collected by the Geological Survey during 1987 and 1989 at wells SBH-1, DDL-1, and DR-1. All samples were analyzed at the Geological Survey laboratory in Arvada, Colo. In addition, isotope analyses were made at the same laboratory for carbon-13, carbon-14, and tritium; at the Geological Survey research laboratory in Reston, Va., for deuterium and oxygen-18; and at the Global Geochemistry Corporation laboratory in Canoga Park, Calif., for sulfur-34. Results of the above analyses are presented in table 8. The data include major-ion chemistry, trace constituents, stable and radioactive isotopes, temperature, pH, specific conductance, and dissolved oxygen. Wells SBH-1 and DR-1 were pumped a total of about 36,000 and 24,000 gallons, respectively, before sampling.

Historical and current (1989) dissolved trace-element concentrations are reported herein for water that was collected, processed, and analyzed by using either ultraclean or other than ultraclean techniques. If ultraclean techniques were used, concentrations are reported in nanograms per liter. If other than ultraclean techniques were used, concentrations are reported in micrograms per liter and may have been affected by contamination introduced during some phase of the procedure.

Aquifer Tests

Aquifer tests were made in two of the wells in the study area (SBH-1 and DR-1). Although well DDL-1 was pumped to obtain water for a chemical analysis, no aquifer-test information is available for that well.

Preparations for the aquifer test in SBH-1 began on August 4, 1987. A 4-inch-diameter, 5-horsepower submersible pump was lowered into the well to a depth of 628.5 feet below land surface. A pressure transducer, which was connected to data loggers at land surface and mounted on the discharge pipe just above the pump, recorded water levels during the test.

On August 5 the well was pumped for 10 hours at a constant rate of 24 gal/min. When the pump was turned off the recovery of water levels was monitored for 30 minutes. Barometric pressure was also monitored during the pump test to determine any effects of air pressure on water levels. The pump was removed from the well on August 6, 1987.

Figure 3 shows graphs of water levels versus time for the pumping and recovery phases of the aquifer test at well SBH-1. Table 9 lists the data for the pumping phase, and table 10 lists the data for the recovery phase of the aquifer test in SBH-1.

Preparations for the aquifer test at DR-1 began on February 3, 1989, when a 4-inch-diameter submersible pump was set at 878.4 feet below land surface. Again, a transducer was mounted on the pump column, about 10 feet above the pump. The pump was started on the afternoon of February 3 at a pumping rate of 7 gal/min. The pumping caused the well to develop and to discharge muddy water. After 108 minutes the water had cleared and the rate was increased to 12 gal/min; after another 30 minutes the rate was increased to 14.5 gal/min and continued at that rate for the duration of the test. The test lasted about 27 hours.

On February 4, when the pump was turned off, recovery of the water levels was measured for a period of about 30 minutes using the same equipment set-up as used on SBH-1. On February 5, 1989, the pump was removed from DR-1. Figure 4 shows the pumping and recovery phase of the aquifer test in DR-1, and tables 11 and 12 list the data.

TABLE 8.--***Water-quality data for selected wells and springs in the study area***

[Abbreviations and symbols: °C, degrees Celsius; IT-FLD, incremental titration in field; mg/L, milligrams per liter; pCi/L, picocuries per liter; µg/L, micrograms per liter; µs/cm, microsiemens per centimeter at 25°C; --, information not available]

Sequence number[1]	Site	Date	Specific conduct-ance (µs/cm)	pH (stand-ard units)	Water temper-ature (°C)	Oxygen, dis-solved (mg/L)	Calcium, dis-solved (mg/L as Ca)	Magne-sium, dis-solved (mg/L as Mg)
			WELLS					
1	SBH-1	08-05-87	400	7.53	29.0	6.4	39	21
2	DDL-1	03-18-87	400	7.97	19.0	2.8	22	27
3	DR-1	02-04-89	390	7.68	22.5	6.4	33	17
			SPRINGS					
4	CORN CREEK SPRINGS	09-25-86	--	--	--	--	--	--
		06-17-87	--	--	--	--	--	--
		08-05-87	--	--	--	--	--	--
		01-05-88	--	--	--	--	--	--
5	COW CAMP SPRING	10-28-81	535	7.60	14.5	--	48	31
		05-10-83	540	7.60	10.0	5.9	50	35
6	WIREGRASS SPRING	10-28-81	535	7.30	9.5	--	69	32
		05-11-83	520	7.30	6.5	6.1	68	32
		03-20-87	--	7.32	4.0	--	71	34
		06-17-87	570	--	13.0	--	70	33
		08-04-87	580	7.34	14.0	5.4	68	33
		01-05-88	585	7.32	4.0	5.0	72	34
		04-06-88	580	7.41	8.0	5.0	72	34
		12-12-88	525	7.30	7.0	--	69	36
7	WAMP SPRING	03-20-87	320	8.15	7.0	--	71	13
8	MORMAN WELL SPRING	10-27-81	666	7.26	11.5	--	81	40
		05-09-83	600	7.60	10.0	5.1	65	41
		10-07-87	740	7.36	12.0	--	84	44
9	SAWMILL SPRING	05-19-88	--	--	--	--	12	29
10	WHITE ROCK SPRING	10-29-81	454	7.42	15.0	--	37	29
		05-10-83	390	7.50	10.0	5.7	38	31
11	SHEEP SPRING	05-19-88	520	7.75	15.0	6.5	31	40
12	LAMB SPRING	05-19-88	500	7.69	13.5	6.1	37	41

TABLE 8.--***Water quality data for selected wells and springs in the study area***--Continued

Sequence number[1]	Sodium, dis-solved (mg/L as Na)	Potas-sium, dis-solved (mg/L as K)	Bicar-bonate, IT-FLD (mg/L as HCO_3)	Car-bonate IT-FLD (mg/L as CO_3)	Sulfate, dis-solved (mg/L as SO_4)	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Nitro-gen ammonia, dis-solved (mg/L as N)	Nitro-gen, ammonia+ organic, dis-solved (mg/L as N)	Nitro-gen, NO_2+NO_3 dis-solved (mg/L as N)	Phos-phorus, dis-solved (mg/L as P)	Barium, dis-solved (µg/L as Ba)
						WELLS							
1	7.3	4.7	197	--	32	6.7	0.5	22	0.02	2.4	<0.10	0.01	120
2	35	5.7	207	--	48	8.9	.6	49	<.01	.2	2.5	.01	74
3	17	7.1	191	--	31	8.1	.7	26	--	--	--	--	160
						SPRINGS							
4	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--
5	21	.7	280	--	9.0	28	.2	16	--	--	--	--	46
	25	.6	300	--	29	29	.2	15	--	--	--	--	44
6	2.7	1.1	350	--	5.0	3.0	.1	12	--	--	--	--	21
	3.2	1.1	360	--	9.0	3.2	.1	12	--	--	--	--	23
	2.8	1.1	374	--	6.9	3.4	.1	12	--	--	--	--	17
	2.8	1.5	--	--	7.1	2.9	.2	12	--	--	--	--	18
	3.1	1.0	372	--	7.3	2.9	.2	12	<.01	.5	.24	<.01	17
	3.1	5.7	383	--	7.7	3.8	.2	12	.01	.2	.26	<.01	18
	2.8	1.0	380	--	7.3	2.6	.2	12	<.01	.3	.23	.01	18
	3.1	1.1	369	--	7.3	2.7	.1	12	--	--	--	--	18
7	10	2.1	293	--	8.4	4.9	.2	24	.04	.3	<.10	.01	430
8	11	.4	400	--	<5.0	24	.1	16	--	--	--	--	29
	12	1.0	390	--	21	12	.1	16	--	--	--	--	23
	13	.5	422	--	23	12	.2	17	.01	<.2	.16	.03	30
9	1.8	.6	162	11	5.9	2.1	.2	6.1	--	--	--	--	<2
10	14	7.0	260	--	<5.0	9.3	.2	47	--	--	--	--	29
	15	7.4	290	--	12	11	.2	44	--	--	--	--	29
11	7.9	1.1	276	--	13	7.1	.2	13	--	--	--	--	10
12	8.7	.6	289	--	24	8.6	.2	12	--	--	--	--	12

TABLE 8.--*Water quality data for selected wells and springs in the study area*--Continued

Sequence number[1]	Beryllium, dissolved (µg/L as Be)	Boron, dissolved (µg/L as B)	Bromide, dissolved (mg/L as Br)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Silver, dissolved (µg/L as Ag)
							WELLS							
1	0.7	--	0.091	<1	<5	<3	<10	<3	<10	6	29	<10	<10	2
2	<.5	--	--	13	--	<3	<10	6	160	17	9	<10	--	--
3	<.5	--	.12	<1	<5	<3	<10	3	<10	17	62	<10	<10	<1
							SPRINGS							
4	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5	<1	--	--	<1	--	<3	<10	<10	<10	21	7	<10	--	--
	.5	160	--	<1	--	<3	<10	<3	<10	22	2	<10	--	--
6	<1	--	--	<1	--	<3	<10	<10	<10	13	1	<10	--	--
	<.5	20	--	<1	--	<3	<10	11	<10	25	1	<10	--	--
	<.5	--	--	1	--	<3	<10	5	<10	8	<1	<10	--	--
	<.5	--	--	<1	--	<3	<10	6	<10	11	<1	<10	--	--
	.7	--	--	<1	<5	<3	<10	<3	<10	<4	<1	<10	<10	<1
	<.5	--	.011	<1	<5	<3	<10	5	<10	<4	1	<10	<10	<1
	<.5	--	<.010	<1	<5	<3	<10	5	<10	8	<1	<10	<10	<1
	<.5	--	.032	3	<5	<3	<10	<3	<10	6	<1	<10	<10	<1
7	<.5	--	--	<1	--	<3	<10	10	<10	12	21	<10	--	--
8	<1	--	--	<1	--	<3	<10	<10	<10	18	1	<10	--	--
	.5	110	--	<1	--	<3	<10	11	<10	20	9	<10	--	--
	<.5	--	.17	<1	<5	<3	<10	5	<10	20	<1	<10	<10	<1
9	<.5	--	<.010	<1	<5	<3	<10	5	<10	<4	1	<10	<10	<1
10	<1	--	--	<1	--	<3	<10	<10	<10	17	<1	<10	--	--
	<.5	130	--	<1	--	<3	<10	8	<10	17	<1	<10	--	--
11	<.5	--	.084	<1	<5	<3	<10	5	<10	8	3	<10	<10	<1
12	<.5	--	.10	<1	<5	<3	<10	4	<10	8	12	<10	<10	<1

TABLE 8.--***Water quality data for selected wells and springs in the study area***--Continued

Sequence number[1]	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)	Delta deuterium (permil)	Delta oxygen-18 (permil)	Tritium, total (pCi/L)	Carbon-13/carbon-12, stable-isotope ratio (permil)	Carbon-14 (percent modern)	Strontium-34/strontium-32, stable-isotope ratio (permil)	Uranium-238/uranium-234, activity ratio	Uranium natural, dissolved (µg/L as U)	Carbon, organic, dissolved (mg/L as C)
						WELLS						
1	510	<6	660	-87.0	-12.10	<0.3	-6.2	9.2	--	--	--	0.7
2	470	<6	18	-98.0	-13.10	<0.6	-5.3	1.3	--	--	--	--
3	810	<6	640	-91.5	-12.55	--	--	--	--	--	--	--
						SPRINGS						
4	--	--	--	-93.0	-12.85	--	--	--	--	--	--	--
	--	--	--	-93.0	-12.90	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	.9
	--	--	--	-93.5	-12.90	--	--	--	--	--	--	--
5	270	<6	160	-90.5	-12.60	--	--	--	--	--	--	--
	290	<6	89	-93.0	-12.60	--	--	--	8.64	3.2	1.7	--
6	71	<6	30	-94.0	-12.80	--	--	--	--	--	--	--
	81	<6	42	-96.0	-12.70	--	-10.7	--	7.24	2.0	0.57	--
	71	<6	31	-91.5	-12.80	--	--	--	--	--	--	--
	82	<6	19	-92.0	-12.55	--	--	--	--	--	--	--
	68	<6	8	-94.0	-12.75	--	--	--	--	--	--	--
	82	<6	26	-97.0	-12.85	--	--	--	--	--	--	--
	70	<6	11	-95.0	-12.95	--	--	--	--	--	--	--
	73	<6	32	-94.5	-12.85	--	--	--	--	--	--	--
7	230	<6	240	-81.0	-10.60	--	--	--	--	--	--	--
8	0	<6	28	-92.5	-12.90	--	--	--	--	--	--	--
	170	<6	30	-91.0	-12.50	--	-9.9	--	9.80	4.9	1.0	--
	180	<6	40	-92.0	-12.60	41	--	--	--	--	--	1.9
9	19	<6	18	-92.0	-12.85	--	--	--	--	--	--	--
10	0	<6	24	-82.0	-9.90	--	--	--	--	--	--	--
	140	<6	24	-85.0	-9.80	--	-8.3	--	9.07	1.9	1.7	--
11	74	<6	28	-96.0	-13.35	--	--	--	--	--	--	--
12	87	<6	15	-92.5	-13.15	--	--	--	--	--	--	--

[1] The sequence number is for use in locating information and analytical results for each site on continuing pages of this table.

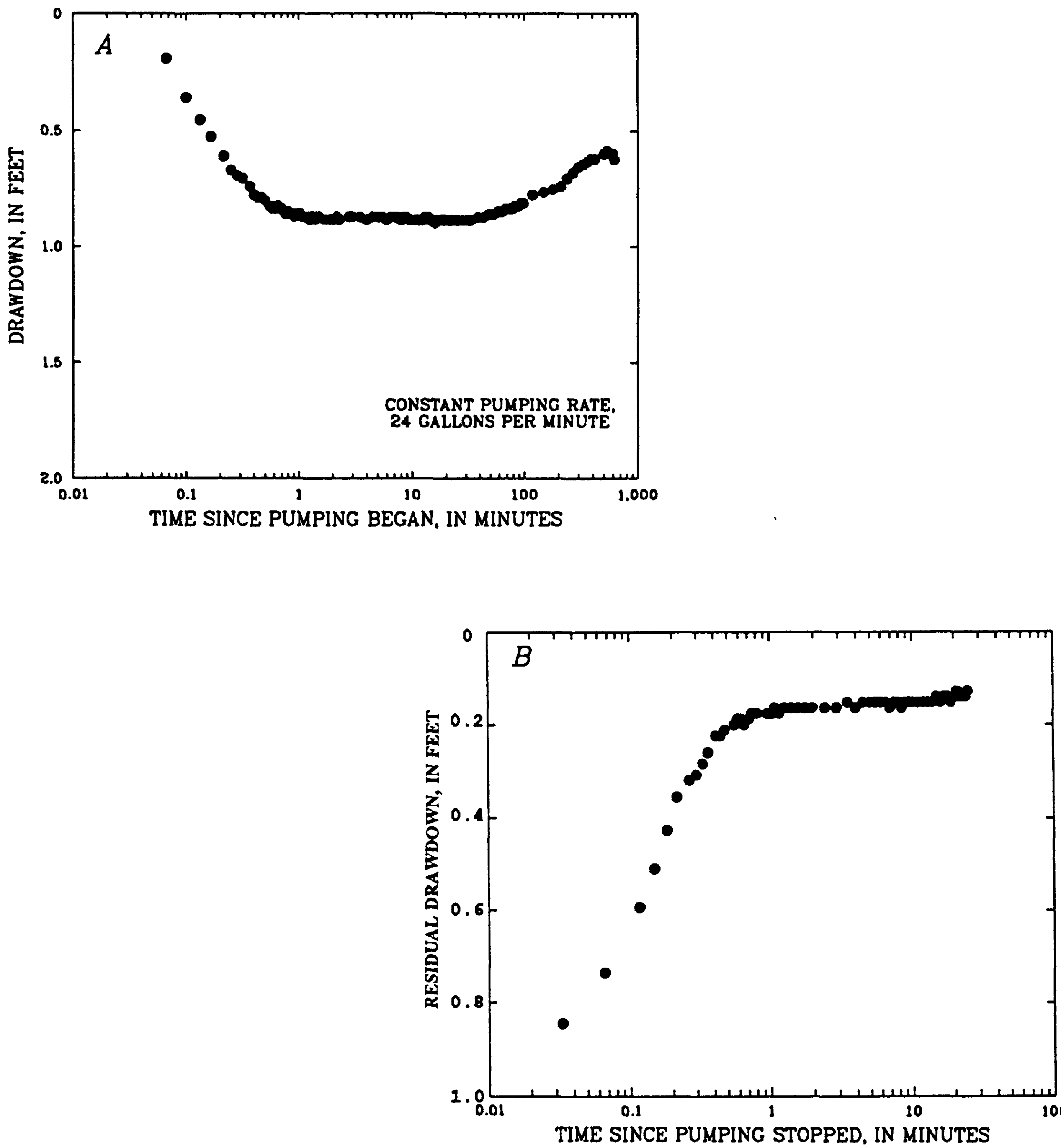


FIGURE 3.--Water-level drawdown (*A*) and recovery (*B*) for a pumping test of well SBH-1, August 5, 1987.

TABLE 9.--***Water levels during a 10.4-hour, constant-discharge aquifer test at SBH-1, August 5, 1987***

[Calculated drawdown of water levels in feet below static water level. Static water level, 581.1 feet below land surface. Average pumping rate, 24 gallons per minute]

Time (minutes since pumping began)	Water level (feet below land surface)	Draw-down (feet)	Time (minutes since pumping began)	Water level (feet below land surface)	Draw-down (feet)	Time (minutes since pumping began)	Water level (feet below land surface)	Draw-down (feet)
0.00	581.10	0.00	1.47	581.97	0.87	19.0	581.98	0.88
.03	582.63	1.53[1]	1.52	581.97	.87	19.5	581.98	.88
.07	581.29	.19	1.70	581.98	.88	20.0	581.98	.88
.10	581.46	.36	1.88	581.98	.88	22.0	581.98	.88
.13	581.55	.45	2.03	581.98	.88	24.0	581.98	.88
.17	581.63	.53	2.18	581.97	.87	26.0	581.98	.88
.22	581.71	.61	2.28	581.98	.88	28.0	581.98	.88
.25	581.77	.67	2.78	581.97	.87	30.0	581.98	.88
.28	581.79	.69	3.0	581.97	.87	31.0	581.98	.88
.32	581.81	.71	3.5	581.97	.87	33.5	581.98	.88
.37	581.84	.74	4.0	581.98	.88	38.5	581.97	.87
.40	581.88	.78	4.5	581.97	.87	43.5	581.97	.87
.43	581.89	.79	5.0	581.97	.87	48.5	581.96	.86
.47	581.89	.79	5.5	581.97	.87	53.5	581.96	.86
.50	581.90	.80	6.0	581.98	.88	58.5	581.95	.85
.55	581.92	.82	6.5	581.97	.87	63.5	581.95	.85
.58	581.94	.84	7.0	581.97	.87	68.5	581.94	.84
.62	581.94	.84	7.5	581.97	.87	73.5	581.94	.84
.65	581.92	.82	8.0	581.98	.88	78.5	581.94	.84
.70	581.94	.84	8.5	581.97	.87	83.5	581.92	.82
.73	581.95	.85	9.0	581.97	.87	88.5	581.92	.82
.77	581.96	.86	9.5	581.98	.88	93.5	581.91	.81
.80	581.95	.85	10.0	581.98	.88	98.5	581.91	.81
.85	581.96	.86	10.5	581.98	.88	118.5	581.88	.78
.88	581.96	.86	11.0	581.98	.88	148.5	581.86	.77
.92	581.97	.87	11.5	581.98	.88	178.5	581.85	.75
.95	581.96	.86	12.0	581.98	.88	208.5	581.84	.74
.98	581.96	.86	12.5	581.98	.88	238.5	581.81	.71
1.03	581.96	.86	13.0	581.97	.87	268.5	581.78	.68
1.07	581.97	.87	13.5	581.97	.87	298.5	581.76	.66
1.10	581.97	.87	14.0	581.97	.87	328.5	581.75	.65
1.13	581.97	.87	14.5	581.98	.88	358.5	581.73	.63
1.18	581.97	.87	15.0	581.98	.88	388.5	581.72	.62
1.22	581.97	.87	15.5	581.98	.88	418.5	581.72	.62
1.25	581.98	.88	16.0	582.00	.90	506.5	581.70	.60
1.28	581.97	.87	16.5	581.98	.88	538.5	581.69	.59
1.32	581.97	.87	17.0	581.98	.88	598.5	581.70	.60
1.37	581.97	.87	17.5	581.98	.88	621.5	581.72	.62
1.40	581.98	.88	18.0	581.98	.88			
1.43	581.97	.87	18.5	581.98	.88			

[1] Pump-discharge pipe did not have a foot valve; consequently, drawdown temporarily increased due to higher pump rate until discharge pipe filled.

TABLE 10.--***Water levels during recovery from a 10.4-hour, constant-discharge aquifer test at SBH-1, August 5, 1987***

[Residual drawdown is calculated drawdown of water levels remaining below static water level. Static water level 581.1 feet below land surface]

Time (minutes since pumping ended)	Water level (feet below land surface)	Residual draw-down (feet)	Time (minutes since pumping ended)	Water level (feet below land surface)	Residual draw-down (feet)	Time (minutes since pumping ended)	Water level (feet below land surface)	Residual draw-down (feet)
0.03	581.84	0.74	0.97	581.18	0.08	7.5	581.15	0.05
.06	581.74	.64	1.02	581.18	.08	8.0	581.15	.05
.12	581.59	.49	1.05	581.18	.08	8.5	581.16	.06
.15	581.51	.41	1.08	581.16	.06	9.0	581.15	.05
.18	581.43	.33	1.17	581.18	.08	9.5	581.15	.05
.22	581.36	.26	1.27	581.16	.06	10.0	581.15	.05
.27	581.32	.22	1.42	581.16	.06	11.0	581.15	.05
.30	581.31	.21	1.57	581.16	.06	12.0	581.15	.05
.33	581.28	.18	1.77	581.16	.06	13.0	581.15	.05
.37	581.26	.16	1.98	581.16	.06	14.0	581.15	.05
.42	581.22	.12	2.43	581.16	.06	15.0	581.14	.04
.45	581.22	.12	2.93	581.16	.06	16.0	581.15	.05
.48	581.21	.11	3.5	581.15	.05	17.0	581.14	.04
.57	581.20	.10	4.0	581.16	.06	18.0	581.14	.04
.60	581.19	.09	4.5	581.15	.05	19.0	581.15	.05
.63	581.19	.09	5.0	581.15	.05	20.0	581.14	.04
.67	581.20	.10	5.5	581.15	.05	21.0	581.13	.03
.72	581.19	.09	6.0	581.15	.05	22.0	581.14	.04
.75	581.18	.08	6.5	581.15	.05	23.0	581.14	.04
.82	581.18	.08	7.0	581.16	.06	24.0	581.14	.04
						25.0	581.13	.03

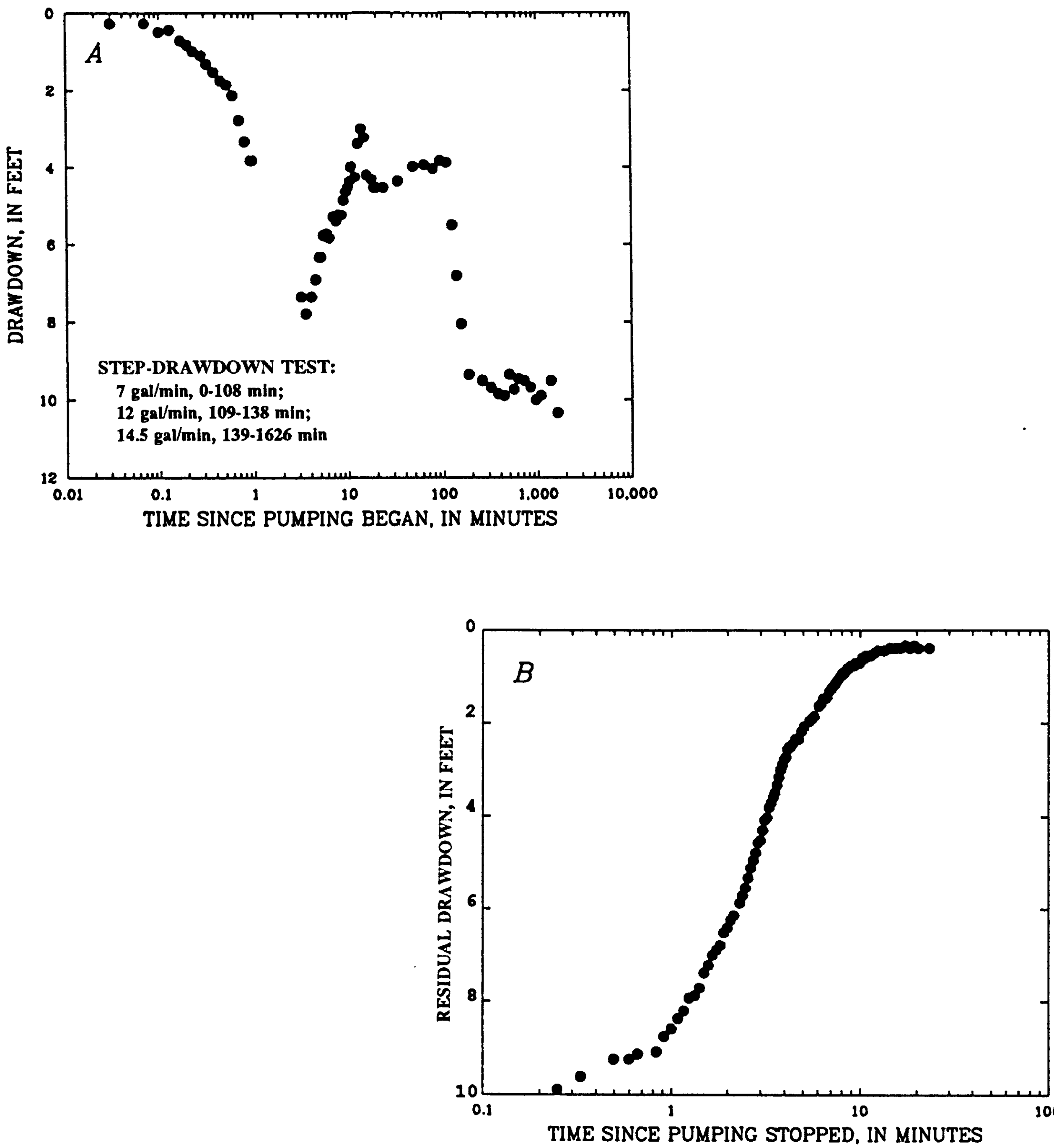


FIGURE 4.--Water-level drawdown (*A*) and recovery (*B*) for a pumping test of well DR-1, February 3-4, 1989.

Table 11.--***Water levels during a 27-hour, step-drawdown aquifer test at DR-1, February 3-4, 1989***

[Calculated drawdown of water levels in feet below static water level. Static water level, 815.49 feet below land surface. Average pumping rate, 24 gallons per minute]

Time (minutes since pumping began)	Water level (feet below land surface)	Draw-down (feet)	Pumping rate (gallons per minute)	Time (minutes since pumping began)	Water level (feet below land surface)	Draw-down (feet)	Pumping rate (gallons per minute)
0.00	815.49	0.00	7.0	10.78	819.46	3.97	
.03	815.76	.27		11.78	819.73	4.24	
.07	815.76	.27		12.78	818.86	3.37	
.10	815.98	.49		13.78	818.48	2.99	
.13	815.93	.44		14.78	818.70	3.21	
.17	816.20	.71		15.78	819.68	4.19	
.20	816.31	.82		17.78	819.79	4.30	
.23	816.47	.98		18.78	820.00	4.51	
.28	816.58	1.09		19.78	820.00	4.51	
.32	816.80	1.31		23.55	820.00	4.51	
.38	817.01	1.52		33.55	819.84	4.35	
.45	817.23	1.74		48.55	819.46	3.97	
.52	817.34	1.85		63.55	819.41	3.92	
.60	817.61	2.12		78.55	819.51	4.02	
.70	818.26	2.77		93.55	819.30	3.81	7.0
.80	818.81	3.32		108.55	819.35	3.86	12.0
.92	819.30	3.81		123.55	820.98	5.49	
.95	819.30	3.81		138.55	822.29	6.80	14.5
3.13	822.83	7.34		153.55	823.54	8.05	
3.50	823.26	7.77		184.55	824.84	9.35	
4.03	822.83	7.34		254.55	825.00	9.51	
4.45	822.39	6.90		314.55	825.17	9.68	
4.95	821.80	6.31		374.55	825.33	9.84	
5.12	821.80	6.31		434.55	825.38	9.89	
5.45	821.25	5.76		494.55	824.84	9.35	
5.95	821.20	5.71		554.55	825.22	9.73	
6.28	821.31	5.82		614.55	824.95	9.46	
6.95	820.76	5.27		715.48	825.00	9.51	
7.45	820.87	5.38		835.48	825.17	9.68	
7.95	820.71	5.22		955.48	825.49	10.00	
8.45	820.71	5.22		1075.48	825.38	9.89	
8.95	820.33	4.84		1378.76	825.00	9.51	
9.45	820.11	4.62		1625.71	825.82	10.33	14.5
9.95	820.00	4.51					
10.45	819.84	4.35					

TABLE 12.--*Water levels during recovery from a 27-hour, step-drawdown aquifer test at DR-1, February 4, 1989*

[Residual drawdown is calculated drawdown of water levels remaining below static water level. Static water level 815.49 feet below land surface]

Time (minutes since pumping ended)	Water level (feet below land surface)	Residual draw-down (feet)	Time (minutes since pumping ended)	Water level (feet below land surface)	Residual draw-down (feet)	Time (minutes since pumping ended)	Water level (feet below land surface)	Residual draw-down (feet)
0.25	825.26	9.89	3.42	819.07	3.70	8.58	816.18	0.81
.33	824.99	9.62	3.50	818.96	3.59	8.75	816.18	.81
.50	824.61	9.24	3.58	818.85	3.48	8.92	816.13	.76
.60	824.61	9.24	3.67	818.68	3.31	9.08	816.13	.76
.67	824.50	9.13	3.75	818.52	3.15	9.25	816.13	.76
.83	824.45	9.08	3.83	818.36	2.99	9.42	816.08	.71
.92	824.12	8.75	3.92	818.25	2.88	9.58	816.08	.71
1.00	823.96	8.59	4.00	818.14	2.77	9.75	816.08	.71
1.08	823.74	8.37	4.08	818.09	2.72	9.92	816.08	.71
1.17	823.58	8.21	4.17	817.92	2.55	10.08	816.02	.65
1.25	823.30	7.93	4.25	817.87	2.50	10.25	815.97	.60
1.33	823.25	7.88	4.33	817.87	2.50	10.42	815.97	.60
1.42	823.09	7.72	4.42	817.82	2.45	10.58	815.97	.60
1.50	822.76	7.39	4.58	817.71	2.34	10.75	815.91	.54
1.58	822.60	7.23	4.75	817.71	2.34	10.92	815.91	.54
1.67	822.38	7.01	4.92	817.54	2.17	11.08	815.91	.54
1.75	822.27	6.90	5.08	817.43	2.06	11.25	815.91	.54
1.83	822.16	6.79	5.42	817.33	1.96	11.42	815.91	.54
1.92	821.89	6.52	5.58	817.27	1.90	11.92	815.86	.49
2.00	821.78	6.41	5.75	817.22	1.85	12.42	815.80	.43
2.08	821.62	6.25	6.08	817.00	1.63	13.42	815.80	.43
2.17	821.51	6.14	6.25	816.95	1.58	14.42	815.75	.38
2.33	821.24	5.87	6.42	816.84	1.47	15.42	815.75	.38
2.42	821.08	5.71	6.58	816.84	1.47	16.42	815.75	.38
2.50	820.91	5.54	6.75	816.78	1.41	17.42	815.70	.33
2.58	820.70	5.33	6.92	816.67	1.30	18.42	815.75	.38
2.67	820.48	5.11	7.08	816.62	1.25	19.42	815.70	.33
2.75	820.32	4.95	7.25	816.57	1.20	20.42	815.75	.38
2.83	820.15	4.78	7.42	816.51	1.14			
2.92	819.93	4.56	7.58	816.46	1.09			
3.00	819.88	4.51	7.75	816.40	1.03			
3.08	819.66	4.29	7.92	816.35	0.98			
3.17	819.45	4.08	8.08	816.29	0.92			
3.25	819.39	4.02	8.25	816.29	0.92			
3.33	819.17	3.80	8.42	816.24	0.87			

DATA FOR SPRINGS

Data were collected at nine springs in the Sheep Range area as part of the NCAP. Data for the springs include location information, discharge measurements, and chemical analyses. Location information for some of the springs are accurate only to the nearest section because parts of the study area are unsurveyed. Altitudes shown for the springs were estimated from 7-1/2-minute topographic maps and are probably accurate to 20 feet. Locations of the nine springs are shown in figure 1 and their location information is listed in table 13.

Discharge measurements at the springs were made when chemical samples were taken by measuring the time required to fill a bottle of known volume. Measurements of flow were not made at Sawmill and Wamp Springs because improvements at the spring sites to facilitate wildlife use made access impossible. Discharge measurements for the other seven springs are listed in table 13.

TABLE 13.--*Locations, flow rates, and other information for springs*

Name	Local site identification[1]	Latitude (degrees, minutes, seconds)	Longitude (degrees, minutes, seconds)	Land-surface altitude (feet above sea level)	Flow measurements: Date	Discharge (cubic feet per second)	Method[2]
Corn Creek Springs	212 S17 E59 34AB	36 26 20	115 21 10	2.930	10-01-85	0.26	A
					04-01-86	.25	A
					10-01-86	.25	A
					04-01-87	.25	A
					10-01-87	.26	A
					04-01-88	.27	A
					10-01-88	--	A
					04-01-89	--	A
Cow Camp Spring	212 S16 E59 02	36 35 01	115 18 26	5,760	05-10-83	.00027	M
Wiregrass Spring	212 S15 E60 07	36 38 00	115 12 29	8,000	03-20-87	.0018	M
					06-17-87	.0018	M
					08-04-87	.0018	M
					01-05-88	.0022	M
					04-06-88	.0018	M
					12-12-88	.0029	M
Wamp Spring	212 S15 E62 18	36 38 30	115 04 12	5,480	03-20-87	--	UM
Morman Well Spring	210 S15 E61 12	36 38 38	115 05 52	6,440	10-07-87	.0014	M
Sawmill Spring	210 S14 E61 32DBCC	36 40 50	115 10 34	8,120	05-19-88	--	UM
White Rock Spring	212 S14 E60 22	36 42 30	115 14 20	5,960	10-29-81	.00032	M
					05-10-83	.00030	M
Sheep Spring	169B S12 E61 23ABCB	36 53 42	115 06 53	5,620	05-19-88	.00056	M
Lamb Spring	210 S12 E62 36ABBA	36 56 42	115 06 21	5,680	05-19-88	.00036	M

[1] See table 1 for explanation.

[2] A, Monthly mean (for month shown) from continous recorder installed July 1985 (Pupacko and others, 1988; 1989); M, measured by timing the filling of a bottle of known volume; UM, unable to measure flow.

A stage recorder was installed in July 1985 at Corn Creek Springs to obtain a continuous record of spring water levels for calculating discharge. The flows listed for this spring in table 13 are monthly means (Pupacko and others, 1988; 1989). As shown in the table, discharge is generally constant at this spring.

Chemical analyses of water from the nine springs are listed in table 8. Methods used for the analyses were the same as those for samples from wells, and are described in the previous section on water-quality analyses.

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