OCCURRENCE OF SELECTED PESTICIDES, NUTRIENTS, SELECTED TRACE ELEMENTS, AND RADIONUCLIDES IN GROUND AND SURFACE WATER FROM WEST-CENTRAL MISSOURI--JULY 1990-MARCH 1991

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Multiply	By	To obtain
acre	0.4047	hectare
foot	0.3048	meter
inch	25.4	millimeter
square mile	259.0	hectare
mile	1.609	kilometer
gallon per minute	0.06308	liter per second

To convert degrees Celsius (°C) to degrees Fahrenheit (°F) use the following:

$$°F = 9/5\ °C + 32.$$

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

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By Andrew C. Ziegler[1], Donald H. Wilkison[2], and Randall D. Maley[3]

ABSTRACT

During 1990, pesticides were detected in water from 29 of 92 wells and the 5 surface-water sites sampled in Bates, Cass, St. Clair, and Vernon Counties in west-central Missouri. Atrazine concentrations exceeded 3 micrograms per liter in samples from 5 wells and 2 surface-water sites. During 1991, pesticides were detected in water from 27 of 100 wells sampled in Bates, Cass, and Vernon Counties. During 1991, the mean tritium concentration was 28.3 picocuries per liter in water samples from 20 wells. Water samples from three wells had tritium concentrations less than 9.0 picocuries per liter.

During 1990, nitrate, as nitrogen, concentrations exceeded 10 milligrams per liter in water samples from 21 of 89 wells. During 1991, nitrate concentrations exceeded 10 milligrams per liter in water samples from 23 of 99 wells and 1 of 3 springs. During 1991, the $\delta^{15}N$ (ratio of ^{15}nitrogen to ^{14}nitrogen in nitrate, relative to atmospheric nitrogen, expressed in per mil) in water samples from 22 wells ranged from +4.2 to +29.2 per mil. All but two of the samples had $\delta^{15}N$ of nitrate values equal to or greater than +10 per mil.

During 1990, alpha radiation concentrations ranged from less than 1 to 33 picocuries per liter. Beta radiation concentrations ranged from less than 1 to 110 picocuries per liter.

During 1991, arsenic concentrations ranged from less than 5 to 10 micrograms per liter. Iron concentrations ranged from less than 50 to 8,600 micrograms per liter. Manganese concentrations ranged from less than 20 to 7,800 micrograms per liter.

INTRODUCTION

Agricultural production is the primary land use in west-central Missouri. The dominant row crops are soy beans, hay, corn, wheat, and grain sorghum. Beef and pork are the principal livestock products. Pesticides and nitrogen fertilizers are used extensively on row crops and may enter ground and surface water. Because ground water is the primary drinking water source for many people in the area, the U.S. Geological Survey (USGS), in cooperation with the Missouri Department of Health (DOH), sampled wells, springs, and surface-water sites in west-central Missouri during 1990 and 1991 to determine concentrations of pesticides, nutrients, nitrogen isotopes, radionuclides, arsenic, iron, and manganese in ground and surface water from

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west-central Missouri. This report contains the results of analyses for pesticides, nutrients, nitrogen isotopes, radionuclides, arsenic, iron, manganese, and selected land-use characteristics for ground- and surface-water samples from Bates, Cass, St. Clair, and Vernon Counties in west-central Missouri (fig. 1).

The percentage of land in agricultural crop production ranged from 25 percent in St. Clair County to 38 percent in Bates County (Missouri Department of Agriculture, 1991). Soybeans were the largest part of the crop acreage in Bates, Cass, and Vernon Counties. The percentage of land devoted to soybean production in these three counties ranged from 10 to 13 percent. Hay, wheat, and corn were the next most abundant crops. Hay was the most abundant crop in St. Clair County, accounting for 13 percent of the total acreage. Soybeans were the next most abundant crop in St. Clair County and were 5 percent of the total acreage. Cash values of cattle exceeded all other crops, except in Cass County, where soybeans were the largest cash crop.

More than 95 percent of all corn and soybean acreage in west-central Missouri was treated with pesticides during 1989 (Missouri Department of Agriculture, 1990; 1991). Atrazine and alachlor were most commonly applied for control of grasses and broadleaf plants. Trifluralin, imazaquin, metribuzin, chlorimuron, and alachlor were used on most of the soybean crops for weed and grass control. Atrazine, alachlor, butylate, cyanazine, and metolachlor were used on most of the corn crops. These nine pesticides account for more than 70 percent of the pesticides used in the State (Smith and Fairchild, 1990). These pesticides began to be used on crops in the early 1950's.

During 1990, dry urea was the most common nitrogen fertilizer applied (Missouri Department of Agriculture, 1991). Nitrogen solutions, ammonium nitrate, and anhydrous ammonia were applied in lesser quantities. Commercial nitrogen fertilizers are manufactured from atmospheric nitrogen and may be distinguished from nitrogen derived from animal wastes (either livestock or human) by the $\delta^{15}N$ relative to atmospheric nitrogen.

Pesticides in ground water may originate from a point source, such as mixing or spilling pesticides near a well, or from a non-point source, such as the application of pesticides to a field and subsequent infiltration to the ground water. Nitrate may be present in ground water because of field application of fertilizers, wastes leaching from feedlots or leaking household septic systems, or leachate from sewage treatment plants. Ground-water recharge that occurred prior to 1952 can be determined by the tritium concentration in the water.

Arsenic, iron, and manganese are trace elements that may have large concentrations in ground water and cause health or esthetic concerns (Missouri Department of Health, oral commun., 1988). Radionuclides, including alpha and beta radiation, radium-226, and radium-228 in ground water may be a health concern. However, trace element and radionuclide concentrations in ground water from west-central Missouri are unknown.

Study Area

Bates, Cass, St. Clair, and Vernon Counties (fig. 1) have a total area of 3,092 mi^2 (square miles) or 1,979,021 acres. The western one-half of St. Clair and much of Bates, Cass, and Vernon Counties are rolling plains that were once covered by native prairie grasses. The area is well suited for agricultural practices, which are the primary land use. The eastern one-half of St. Clair County is a mixture of pasture and wooded uplands with few crops grown. Except for northern Cass County, surface water drains from west to east. Annual precipitation ranges from 36 in. (inches) in Cass County to 40.5 in. in Vernon County.

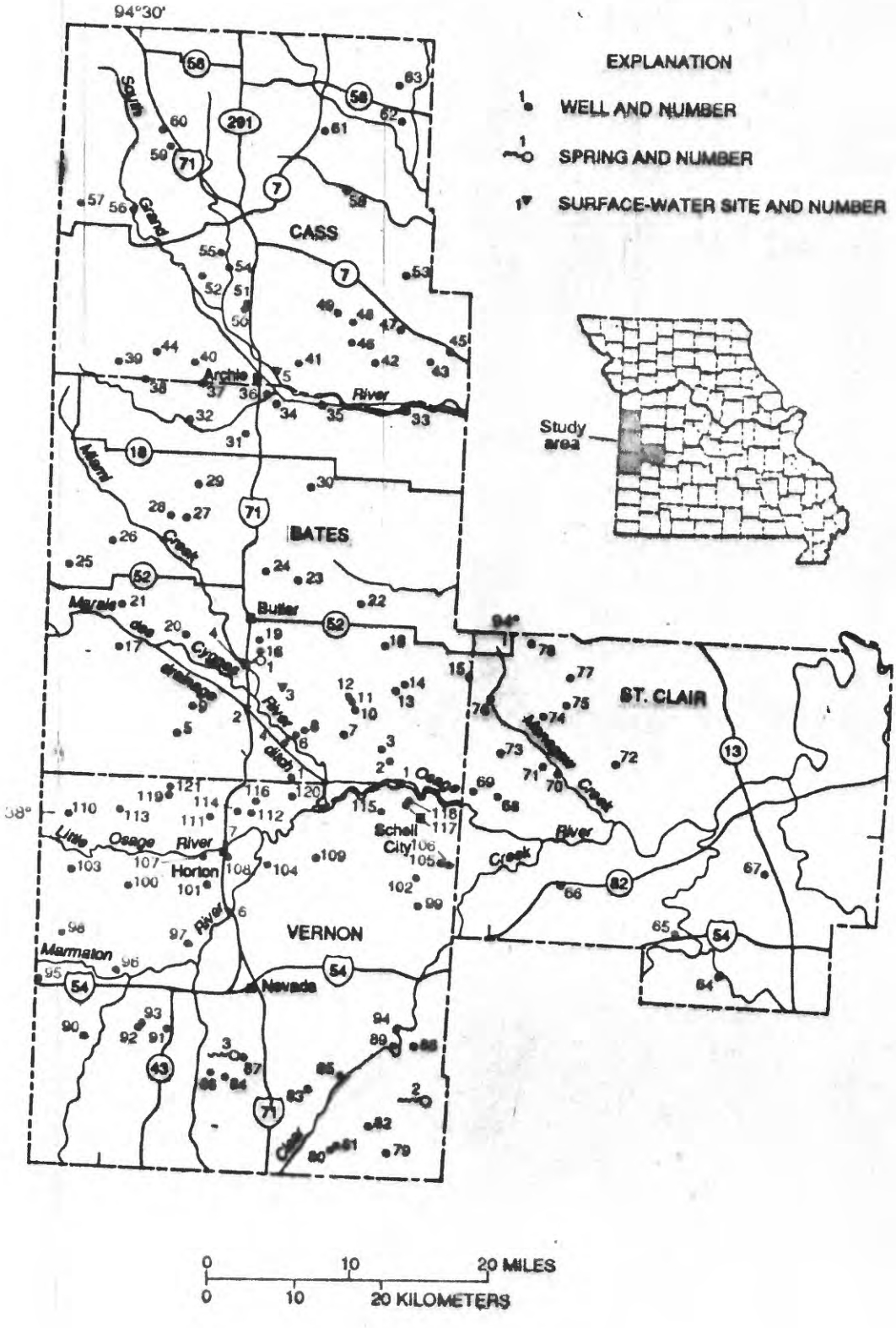

Figure 1.--Location of wells, springs, and surface-water sites.

Extensive alluvial deposits of Holocene age are associated with the four major streams: the Marais des Cygnes, the Marmaton, the Osage, and the South Grand Rivers (fig. 1) that drain the study area. These alluvial deposits can be a local source of ground water. The largest stream valleys have alluvial deposits of 30 to 50 ft (feet) of clay, silt, and sand that are underlain by several feet of gravel and coarse sand (Gentile, 1976). Alluvial wells can yield from 30 to 100 gpm (gallons per minute; Kleeschulte and others, 1985). Pleistocene terrace gravels are isolated sources of small quantities of ground water (Gentile, 1976).

Cyclic sediments of Pennsylvanian age, consisting of limestone, shale, sandstone, coal, and underclays, dominate the near-surface geology of the study area (fig. 2). The thickness of the Pennsylvanian rocks ranges from 0 to 750 ft; the overall thickness of the units increases to the northwest. These rocks have been described as a leaky confining unit for the underlying rocks of Mississippian age (Kleeschulte and others, 1985) and as part of the Western Interior Plains confining system for the Ozark Plateaus aquifer system (Imes, 1990). Sandstones and fractured limestones are the principal sources of water. Depth to water in Pennsylvanian rocks ranges from 15 to 40 ft. Recharge primarily is through precipitation. Well yields range from 1 to 40 gpm, but some wells do not yield during extended dry weather conditions. Most of the wells sampled in this study were completed in Pennsylvanian rocks.

Rocks of Mississippian age in the study area primarily are cherty limestones of the Meramecian, Osagean, and Kinderhookian Series and crop out in St. Clair and eastern Vernon Counties near the Osage River or its tributaries. Wells completed in Mississippian rocks generally have a range of yields from 15 to 20 gpm. Well yields often are increased by solution-widened joints in the rock. Ground water from Mississippian rocks have greater dissolved solids and salinity concentrations than ground water from Pennsylvanian rocks (Gann and others, 1974). Ground water from Mississippian rocks primarily is used for irrigation or livestock purposes in the study area.

Rocks of Ordovician age of the Jefferson City Dolomite are at the surface in southern and eastern St. Clair County. Wells completed in Ordovician rocks have the largest yields of any of the wells in the study area and are the primary source for municipal-, industrial-, and irrigation-water supplies (Kleeschulte and others, 1985). Only one well was sampled in the Jefferson City Dolomite because there are few domestic-supply wells completed in this formation.

Previous Investigations

The geology, hydrology, and water quality of west-central Missouri have been previously studied, but the occurrence of pesticides and other constituents analyzed in this study in ground or surface water is unknown. The geology of Vernon County was described by Greene and Pond (1926) and includes some well data, mostly from deeper wells completed in rocks of Mississippian age. Gann and others (1974) described the quality and availability of ground and surface water and evaluated the aquifers in the area. Kleeschulte and others (1985) examined the ground-water resources of Barton, Bates, and Vernon Counties. This work included description and evaluation of the aquifers, potentiometric surface maps, water-quality data, and well locations. A geologic report on Bates County by Gentile (1976) included chemical analyses from six wells. A report by Gentile (1982) described the geology of the Belton Ring-Fault Complex in Cass County. Previous ground-water data for Cass and St. Clair Counties are limited to a few deep (greater than 100 ft) municipal wells. Most of the wells sampled during 1990 and 1991 were less than 70 ft deep.

Although the occurrence of pesticides in west-central Missouri is unknown, other studies have been completed that describe the occurrence of pesticides and nitrate in other aquifers in the State. During 1986 and 1987, Mesko and Carlson (1988) sampled ground and surface water from the Mississippi River alluvium in southeastern Missouri and analyzed samples for 34 pesticides. Pesticides were detected in water from

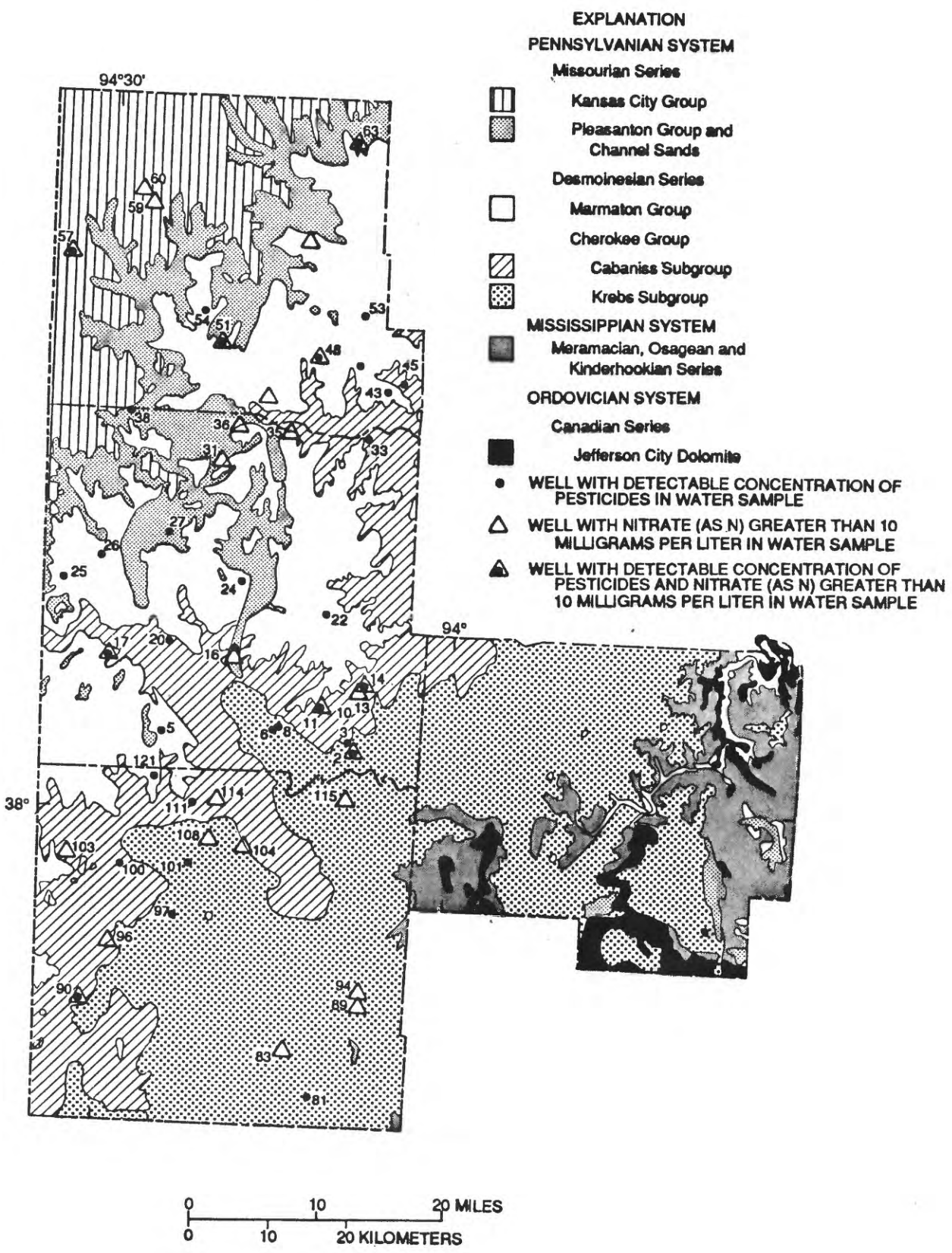

Figure 2.--Location of wells with water samples that had detectable concentrations of pesticides or nitrate concentrations greater than 10 milligrams per liter in relation to geologic formations (geology from Missouri Department of Natural Resources, 1979).

27 percent of the 124 wells sampled. Alachlor, atrazine, cyanazine, metolachlor, metribuzin, propachlor, and trifluralin were among the most frequently detected pesticides in water. Nitrite plus nitrate concentrations exceeded 10 mg/L (milligrams per liter) in water from 18 percent of the 137 wells sampled. Pesticides were detected in water from all five of the surface-water sites sampled.

Sievers and Fulhage (1990) sampled ground water from two counties in northwestern Missouri, two counties in central Missouri, parts of four counties in east-central Missouri, and in the Missouri River alluvium in central Missouri during 1987 and 1988. Pesticides were detected in water from 49 of 101 wells sampled. Ground water from east-central Missouri had the largest detection frequency for pesticides. Nineteen of the 25 wells sampled had detectable pesticide concentrations. Nitrate as nitrogen concentrations exceeded 10 mg/L in water from 33 of 101 wells sampled. The well distance from livestock feeding areas was a significant factor in determining which wells had water with nitrate concentrations exceeding 10 mg/L. Twenty-five of the 33 wells with nitrate concentrations exceeding 10 mg/L in water samples were within 500 ft of a livestock feeding area. Water from 13 of 26 wells sampled in northwestern Missouri had nitrate concentrations greater than 10 mg/L.

During 1988 and 1989, Ziegler and others (1993) sampled two reaches of the Missouri River alluvium between the Iowa border and central Missouri for pesticides, nitrite plus nitrate, arsenic, and iron concentrations in ground and surface water. Pesticides were detected in water samples from 10 of 80 wells sampled during 1989 and in water samples from all 14 of the surface-water sites. Atrazine was the most frequently detected pesticide. Nitrite plus nitrate concentrations, as nitrogen, exceeded 10 mg/L in water samples from 10 of 82 wells. All but one of the wells with pesticides detected or nitrite plus nitrate concentrations exceeding 10 mg/L in water samples were less than 45 ft deep.

The $\delta^{15}N$ of nitrate (ratio of ^{15}nitrogen to ^{14}nitrogen in nitrate, relative to atmospheric nitrogen, expressed in per mil) in ground water can be useful in determining the origin of the nitrogen source. Kreitler (1975) reported that $\delta^{15}N$ relative to the atmospheric nitrogen standard is largest for nitrate originating from animal wastes. The volatilization of ammonia in animal wastes is the principal factor that controls the $\delta^{15}N$ (Kreitler, 1975). Values of $\delta^{15}N$ of nitrate derived from animal waste are greater than +10 per mil. Values of $\delta^{15}N$ of nitrate derived from fertilizers or oxidation of soil nitrogen are less than for nitrate derived from feedlot or septic wastes (Spalding and others, 1982).

Selection and Description of Sampling Sites

During 1990, wells, springs, and surface-water sites were selected for sampling in Bates, Cass, St. Clair, and Vernon Counties. The University of Missouri Extension office in each county provided a list of well owners in the county. Land-use questionnaires were mailed to these owners. Well owners who responded to the questionnaire were selected for wide areal distribution by dividing the study area in 16 sections of about equal area. Within each section, eight wells were selected for sampling. Because a random sampling of domestic drinking water was desired, wells were not excluded from sampling if chemicals were mixed near the well. No wells were sampled in the southwestern one-fourth of Vernon County and the middle and eastern part of St. Clair County because public-water supplies were available. Water from three springs was sampled because local residents use these springs for drinking water. Surface water was sampled from the six largest streams in the area; one pond used for drinking water also was sampled.

During 1990 and 1991, selected well data were collected for the wells sampled (table 1, at the back of this report). Well depths were measured or were provided by the owners. Well depths were available for 116 of the 120 wells sampled. Well depths ranged from 8.0 to 310.0 ft below ground surface with a mean

depth of 63 ft. Well diameter ranged from 2 to 192 in. with a mean of 41 in. Water levels in the wells ranged from 0.3 to 86.6 ft below land surface with a mean of 12.3 ft for the 46 wells where water levels were measured. Most of the sampled wells were hand dug and rock- or brick-lined.

During 1991, wells, springs, and surface-water sites were sampled in Bates, Cass, and Vernon Counties. No samples were collected in St. Clair County based on the results of sampling during 1990. Well depths ranged from 8.0 to 240.0 ft with a mean of 49 ft (table 1). Depth information was available for 96 of the 100 wells sampled. Well diameter ranged from 4 to 192 in. with a mean of 45 in. Water levels ranged from 1.6 to 29.4 ft below ground surface with a mean of 12.5 ft for the 47 wells where water levels were measured.

Land-use data were collected in 1990 and 1991, including distance of the well from the chemical-mixing area, distance from feedlot, distance from the septic system, and the percentage of land area with row crops within 0.25 mi (mile) of the well. The distance from chemical-mixing area was available for 91 wells (table 1). Eighteen wells (19.8 percent) had chemicals mixed less than 100 ft from the well; 19 wells (20.9 percent) had chemicals mixed between 100 ft and 0.25 mi of the well, and 54 wells (59.3 percent) had chemicals mixed greater than 0.25 mi from the well. The well distance to a feedlot was available for 104 wells (table 1). Thirty-nine wells (37.5 percent) were located within 100 ft of a feedlot; 35 wells (33.7 percent) were located between 100 ft and 0.25 mi of a feedlot, and 30 wells (28.8 percent) were located more than 0.25 mi from a feedlot. The well distance from the septic system was available for 90 wells. Twenty-nine wells (32.2 percent) were less than 100 ft from the septic system; 55 wells (61.1 percent) were located between 100 ft and 0.25 mi of the septic system, and 6 wells (6.7 percent) were located more than 0.25 mi from the septic system. The percentage of land area with crops within 0.25 mi of the well ranged from 0 to 95 percent, with a mean of 34.2 percent.

METHODS

Ground-water samples were collected after purging the well system for at least 10 minutes or until the water reached a constant temperature. The pond sample was collected in a similar manner because the pond also was instrumented with a well pump. The sample was collected directly from the spigot nearest the well without passing through any hoses. No samples were collected that passed through water treatment or softening systems. Surface-water samples, with the exception of the pond sample, were collected for pesticide analysis from a depth-integrated sample collected in the middle of the stream.

During 1990, all samples were unfiltered. Water samples were collected in 1-L (liter) glass bottles, chilled, and maintained at 4 °C (degrees Celsius) for pesticide analyses at the University of Iowa Hygienic Laboratory. The detection limit for pesticides analyzed by the University of Iowa Hygienic Laboratory was 0.1 µg/L. Samples were collected in 125-mL (milliliter) amber glass bottles, chilled, and maintained at 4 °C for 20 duplicate pesticide analyses at a USGS laboratory. The detection limit for pesticides analyzed by the USGS was 0.05 µg/L, except for cyanazine, which had a detection limit of 0.2 µg/L. Subsamples from the 125-mL amber glass bottle were used for screening by enzyme-linked immunosorbent assay (ELISA) for triazine and Cl-acetamide herbicides. The detection limit for ELISA was 0.2 µg/L. Samples analyzed by the DOH for nitrite plus nitrate were collected in 125-mL amber glass bottles and preserved with sulfuric acid to inhibit bacterial growth. Samples analyzed by the USGS for nitrite plus nitrate were collected in 250-mL brown polyethylene bottles to which 1 mL of mercuric chloride was added to inhibit bacterial activity, chilled, and maintained at 4 °C until analysis. Samples for alpha radiation, beta radiation, radium-226, and radium-228 were collected in 1-L polyethylene bottles.

During 1991, samples collected for pesticide analysis by the USGS were treated in the same manner as for the 1990 sampling. Samples analyzed for a different suite of pesticides by the DOH laboratory were collected in two 1-L glass bottles, chilled, and maintained at 4 °C until analysis. Samples analyzed for tritium concentrations were collected in 1-L amber glass bottles fitted with polyconic Teflon[1] lids with no air space in the bottle. Unfiltered nitrite plus nitrate samples analyzed by the DOH were collected and treated the same as during 1990. Selected samples were collected for dissolved nutrients, ammonia, nitrite, nitrite plus nitrate, and orthophosphate and the $\delta^{15}N$ of dissolved nitrate in water. Dissolved samples were filtered through a 0.1 μm (micrometer) polycarbonate membrane using a peristaltic pump as a pressure source and a polyvinyl chloride filter holder. The samples were filtered into a 250-mL brown polyethylene bottle to which 1 mL of mercuric chloride was added to inhibit bacterial activity, chilled, and maintained at 4 °C until analysis at the laboratory. Samples analyzed for arsenic, iron, and manganese concentrations were collected in 125-mL glass bottles and acidified to a pH value of less than 2.0 with nitric acid.

All samples collected during 1990 and 1991 were screened for concentrations of triazine herbicides using ELISA methods. Triazine herbicides, including ametryn, atrazine, cyanazine, atrazine degradation products (desethylatrazine, deisopropylatrazine, and hydroxyatrazine), prometon, prometryn, propazine, and simazine react positively to this screening test. During 1990, selected samples also were screened for concentrations of Cl-acetamide herbicides that included alachlor, metolachlor, and metribuzin, using an ELISA sensitive to these herbicides. Samples collected during 1990 and 1991 were analyzed by ELISA for herbicides within 5 days after collection at a USGS laboratory. Results were quantified by comparison to standards using a differential photometer and the detection limit was 0.2 μg/L (microgram per liter; Thurman and others, 1990). The ELISA results were used as quality control checks of data obtained from the other laboratories. During 1991, samples with detectable triazine herbicide concentrations by ELISA were used to determine which samples to send to the laboratory.

Tritium concentrations were determined at a USGS laboratory with an enriched liquid scintillation method having a detection limit of 1.0 pCi/L (picocurie per liter). Two blind-duplicate tritium samples were analyzed.

Unfiltered (hereafter referred to as total) nitrite plus nitrate concentrations were determined by the DOH and USGS for the 1990 samples. The 1991 samples for total nitrite plus nitrate concentrations were determined by the DOH and the filtered (hereafter referred to as dissolved) nutrient concentrations, including ammonia, nitrite, nitrite plus nitrate, and orthophosphate, were determined by the USGS. Duplicate samples were analyzed by both laboratories. The $\delta^{15}N$ values of nitrate in water samples were determined by Global Geochemistry Corporation. Two blind-duplicate nitrogen-isotope samples were analyzed.

During 1991, arsenic, iron, and manganese concentrations in water samples were analyzed by the DOH. Concentrations of arsenic, iron, and manganese are total recoverable. During 1990, samples were analyzed by the DOH for alpha radiation, beta radiation, radium-226, and radium-228 concentrations. Alpha radiation concentrations were analyzed with a low-level proportional counter and reported relative to americium-241 in picocuries per liter. Beta radiation concentrations were analyzed with a low-level proportional counter and reported relative to cesium-137 in picocuries per liter. Radium-226 and radium-228 concentrations were analyzed by DOH and are considered to be total recoverable in picocuries per liter.

Values of specific conductance, pH, and water temperature were determined at the time of sampling. Specific conductance was measured using a portable conductivity meter with temperature compensation designed to express readings in microsiemens per centimeter at 25 °C. The potentiometric method was used

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

to determine the pH value. The pH values were measured using a portable pH meter calibrated with standard buffers bracketing the expected sample pH value. Water temperature was measured using a mercury thermometer to the nearest 0.5 °C.

PESTICIDES IN GROUND WATER, SPRINGS, AND SURFACE WATER

During 1990, water samples from 120 wells, 3 springs, and 7 surface-water sites were analyzed for triazine herbicide concentrations by ELISA. Triazine herbicide concentrations were greater than the detection limit of 0.2 µg/L in water samples from 33 wells and 7 surface-water sites (table 2, at the back of this report). Water samples from 37 wells, 1 spring, and 7 surface-water sites were analyzed for Cl-acetamide concentrations by ELISA. The Cl-acetamide herbicide concentrations were greater than the detection limit of 0.2 µg/L in water samples from 12 wells and 1 surface-water site.

During 1990, water samples from 92 wells, 2 springs, and 5 surface-water sites were sent to laboratories to be analyzed for pesticide concentrations. All samples that had detectable concentrations of triazine herbicide by ELISA were sent to the laboratory. Based on laboratory analyses, one or more of the following pesticides, alachlor, atrazine, cyanazine, desethylatrazine, deisopropylatrazine, metolachlor, metribuzin, prometon, propazine, or simazine, was detected in water samples from 29 wells and 5 surface-water sites. Atrazine was the most commonly detected pesticide and was detected in water samples from 25 wells. Atrazine was detected in water samples from all five of the surface-water sites analyzed. Atrazine concentrations ranged from less than 0.05 to 8.4 µg/L and exceeded 3.0 µg/L in water samples from 5 wells and 2 surface-water sites. Wells 5, 25, 38, and 48 (fig. 1) had pesticides detected in water samples and had water from surface impoundments added to the wells during dry weather. Atrazine concentrations in water samples from three of these wells were greater than 3.0 µg/L. No pesticides were detected in water samples from the 15 wells sampled in St. Clair County.

Well characteristics and land-use data are summarized in table 3 for wells sampled during 1990. The mean well depth with pesticides detected in water samples was 46 ft. The mean well depth without pesticides detected in the water samples was 68 ft. The mean well diameter for wells with pesticides detected was 55 in. The mean well diameter was 37 in. for wells without pesticides detected in water samples. The average percentage of row crops within 0.25 mi of the wells with pesticides detected was 39.8 percent. The average percentage of row crops within 0.25 mi of the wells without pesticides detected was 25.7 percent.

During 1991, water samples from 100 wells, 3 springs, and 2 surface-water sites in Bates, Cass, and Vernon Counties were analyzed for triazine herbicide concentrations by ELISA. Triazine herbicide concentrations were greater than the detection limit of 0.2 µg/L in water samples from 32 wells and 2 surface-water sites (table 2). No samples were collected from St. Clair County based on the lack of any pesticides detected in wells during 1990.

Water samples collected during 1991 from 49 wells were sent to a USGS laboratory to be analyzed for pesticide concentrations. All water samples with detectable concentrations of herbicides by ELISA were sent to the USGS laboratory. Alachlor, atrazine, cyanazine, desethylatrazine, deisopropylatrazine, metolachlor, metribuzin, prometon, propazine, or simazine were detected in water samples from 27 wells. Atrazine was the most commonly detected pesticide and was detected in water samples from 26 wells. Atrazine was detected in samples from wells 5, 38, and 48 (fig. 1) that had surface water added to the well, but none of the concentrations exceeded 3.0 µg/L. The atrazine concentration exceeded 3.0 µg/L in the water sample from well 27.

Table 3–Summary of pesticide detections and well and land-use data for wells

Description	Bates, Cass, St. Clair, and Vernon Counties during 1990		Bates, Cass, and Vernon Counties during 1990		Bates, Cass, and Vernon Counties during 1991	
	Pesticides detected in water samples	Pesticides not detected in water samples	Pesticides detected in water samples	Pesticides not detected in water samples	Pesticides detected in water samples	Pesticides not detected in water samples
Number of wells	29	91	29	76	27	73
Range of well depth, in feet	8.0 - 200	11 - 310	8.0 - 200	14 - 240	8.0 - 200	15 - 240
Mean well depth, in feet (number of wells)	46 (28)	68 (88)	46 (28)	50 (73)	44 (27)	51 (69)
Range of well diameter, in inches	6 - 168	4 - 192	6 - 168	4 - 192	6 - 168	4 - 192
Mean well diameter, in inches (number of wells)	55 (29)	37 (89)	55 (29)	42 (74)	53 (27)	41 (71)
Distance of well from chemical-mixing area[a]						
Number of wells-- less than 100 feet	10	8	10	8	6	11
Number of wells-- 100 feet to 0.25 mile	9	10	9	10	7	12
Number of wells-- more than 0.25 mile	8	46	8	46	12	41
Total	27	64	27	64	25	64
Average percentage of land area with row crops within 0.25 mile of well	39.8	25.7	39.8	26.4	39.4	27.1

[a] Distance of well from chemical-mixing area not available for all wells.

Well characteristics and land-use data are summarized in table 3 for wells sampled for pesticides during 1991. The mean well depth was 44 ft for wells with pesticides detected in water samples. The mean well depth was 51 ft for wells without pesticides detected in water samples. The mean well diameter was 53 in. for wells with pesticides detected in water samples. The mean well diameter was 41 in. for wells without pesticides detected in water samples. Thirteen of the wells with pesticides detected in water samples were within 0.25 mi from the pesticide mixing area, and 41 of the wells without pesticides detected were more than 0.25 mi from the mixing area. The average percentage of row crops within 0.25 mi of the wells with pesticides detected was 39.4 percent. The average percentage of row crops within 0.25 mi of the wells without pesticides detected was 27.1 percent.

Water samples from wells 6, 19, 22, 51, 57, 63, 81, and 111 (fig. 1) were analyzed by the DOH laboratory for concentrations of 2,4-D, endrin, lindane, methoxychlor, pp' DDT, silvex, and toxaphene. Detection limits for 2,4-D, endrin, lindane, and silvex were 0.04 µg/L. Detection limits for methoxychlor and pp' DDT were 0.12 µg/L. The detection limit for toxaphene was 3.0 µg/L. Concentrations of these constituents in all samples were less than the detection limit.

Atrazine concentrations in wells with detections ranged from 0.10 to 8.2 µg/L during 1990 and from 0.10 to 0.68 µg/L during 1991. Mean atrazine concentrations in wells with detections was 1.2 µg/L during 1990 and 0.29 µg/L during 1991.

During 1991, water samples from 20 wells were analyzed for tritium concentrations. The mean tritium concentration was 28.3 pCi/L. Wells 61, 90, and 117 had tritium concentrations of less than or equal to 9.0 pCi/L. The average age of ground water with tritium concentrations of less than 6.4 pCi/L is older than 1953 (Hendry, 1988).

About two-thirds of the wells that had water samples with pesticide detections were in the Marmaton or Cherokee Groups of Pennsylvanian age (tables 1 and 2; and fig. 2). These groups contain more sandstones and siltstones than do other groups in the study area. Six of the 29 wells that had detectable pesticides in water samples withdrew ground water from the Kansas City or Pleasanton Groups. The secondary permeability of many of the limestones in these groups can be large. The Pleasanton Group contains a number of small sandstone and siltstone units of limited areal extent. The sandstone and siltstone members have larger permeabilities than the shales that make up most of the Pleasanton Group.

NUTRIENTS AND NITROGEN-15 ENRICHMENT IN GROUND WATER

During 1990, the nutrient analyzed was nitrite plus nitrate, as nitrogen, in milligrams per liter. During 1991, the nutrient analyses included total nitrite plus nitrate, dissolved ammonia, nitrite, nitrite plus nitrate, and orthophosphate. Nitrite plus nitrate concentrations are considered to be nitrate because nitrite concentrations were less than 5 percent of the nitrite plus nitrate concentrations. Nitrite plus nitrate concentrations as nitrogen will be referred to as nitrate in this report even though a small part of the concentration may be from nitrite.

During 1990, water samples from 89 wells were analyzed for nitrate concentrations. Nitrate concentrations were equal to or exceeded the Missouri drinking-water-supply criteria of 10 mg/L (Missouri Department of Natural Resources, 1992) in water samples from 21 wells (24 percent of wells sampled; table 4, at the back of this report). Nitrate concentrations were equal to or exceeded the detection limit in water samples from 66 wells (74 percent of wells sampled). The analytical detection limit was 0.05 mg/L for samples

Table 5–Summary of nitrate concentrations and $\delta^{15}N$ values in water samples from wells and well and land-use data

[$\delta^{15}N$, ratio of ^{15}nitrogen to ^{14}nitrogen in nitrate, relative to atmospheric nitrogen, expressed in per mil; >, greater than; mg/L, milligrams per liter; ≥, greater than or equal to; D.L., detection limit of 0.05 mg/L for samples analyzed by Missouri Department of Health laboratory and 0.10 mg/L for samples analyzed by U.S. Geological Survey laboratory; <, less than]

	Bates, Cass, St. Clair, and Vernon Counties during 1990			Bates, Cass, and Vernon Counties during 1990			Bates, Cass, and Vernon Counties during 1991				
	Nitrate concentrations			Nitrate concentrations			Nitrate concentrations			$\delta^{15}N$	
Description	>10 mg/L	≥D.L. mg/L	<D.L. mg/L	>10 mg/L	≥D.L. mg/L	<D.L. mg/L	>10 mg/L	≥D.L. mg/L	<D.L. mg/L	>+10 per mil	<+10 per mil
Number of wells	21	66	23	21	64	18	23	80	19	20	2
Range of well depth, in feet	14 - 200	14 - 260	11 - 310	14 - 200	14 - 200	17- 240	16 - 100	8.0 - 200	15- 240	14 - 100	22 - 200
Mean well depth, in feet (number of wells)	41 (21)	45 [a](64)	109 (23)	41 (21)	39 [a](62)	95 (18)	37 (23)	40 [a](77)	94 [b](18)	33 (20)	111 (2)
Range of well diameter, in inches	4 - 168	4 - 192	5 - 60	4 - 168	4 - 192	5 - 60	6 - 120	4 - 192	4 - 60	4 - 168	6 - 60
Mean well diameter, in inches (number of wells)	47 (21)	51 [b](65)	20 [b](22)	47 (21)	52 [b](63)	22 [b](17)	50 (23)	50 [b](79)	21 [b](18)	53 (20)	33 (2)
Distance of well from chemical-mixing area[c]											
Number of wells-- less than 100 feet	3	11	3	3	11	3	3	14	3	2	0
Number of wells-- 100 feet to 0.25 mile	6	13	1	6	13	1	7	18	2	8	0
Number of wells-- more than 0.25 mile	11	32	10	11	32	10	13	40	11	10	2
Total	20	56	14	20	56	14	23	72	16	20	2
Average percentage of row crops within 0.25 mile of well	35.7	28.1	32.8	35.7	28.6	34.2	36.1	29.6	26.3	35.5	12.5

Table 5–Summary of nitrate concentrations and $\delta^{15}N$ values in water samples from wells and well and land-use data–Continued

Description	Bates, Cass, St. Clair, and Vernon Counties during 1990			Bates, Cass, and Vernon Counties during 1990			Bates, Cass, and Vernon Counties during 1991				
	Nitrate concentrations			Nitrate concentrations			Nitrate concentrations			$\delta^{15}N$	
	>10 mg/L	≥D.L. mg/L	<D.L. mg/L	>10 mg/L	≥D.L. mg/L	<D.L. mg/L	>10 mg/L	≥D.L. mg/L	<D.L. mg/L	>+10 per mil	<+10 per mil
Distance of well from feedlot[d]											
Number of wells less than 100 feet	14	26	7	14	24	6	12	25	5	13	2
Number of wells 100 feet to 0.25 mile	4	23	6	4	23	5	7	29	4	6	0
Number of wells more than 0.25 mile	3	14	4	3	14	4	4	21	6	1	0
Total	21	63	17	21	61	15	23	75	15	20	2
Distance of well from septic system[e]											
Number of wells less than 100 feet	8	20	3	8	10	2	9	27	3	10	0
Number of wells 100 feet to 0.25 mile	10	36	8	10	36	2	13	44	9	10	1
Number of wells more than 0.25 mile	2	2	1	2	8	1	1	3	1	0	1
Total	20	58	12	20	54	5	23	74	13	20	2

[a] Well depth was not available for all wells.
[b] Well diameter was not available for all wells.
[c] Distance of well from chemical-mixing area was not available for all wells.
[d] Distance of well from feedlot was not available for all wells.
[e] Distance of well from septic system was not available for all wells.

analyzed by the DOH and 0.10 mg/L for samples analyzed by USGS laboratories. No water samples from St. Clair County had nitrate concentrations exceeding 10 mg/L. A summary of nitrate concentrations and $\delta^{15}N$ values from water samples and well and land-use data is in table 5.

The mean well depth was 41 ft for wells with water samples having nitrate concentrations greater than 10 mg/L. The mean well depth was 109 ft for wells with nitrate concentrations less than 0.05 mg/L. Well diameters for wells with water samples having nitrate concentrations equal to or greater than 0.05 mg/L averaged 51 in. Well diameters for wells with water samples having nitrate concentrations less than 0.05 mg/L averaged 20 in.

Twenty-four wells with water samples having nitrate concentrations equal to or greater than the detection limit were less than 0.25 mi from the chemical-mixing area and 32 wells were more than 0.25 mi from the mixing area. The average percentage of row crops within 0.25 mi of the wells with water samples having nitrate concentrations equal to or exceeding the analytical detection limit was 28.1 percent. The average percentage of row crops within 0.25 mi of the wells with water samples having nitrate concentrations less than the analytical detection limit was 32.8 percent. Fourteen of the wells with nitrate concentrations in water samples greater than 10 mg/L were less than 100 ft from the nearest feedlot. Fifty-six wells with water samples having nitrate concentrations equal to or greater than the detection limit were less than 0.25 mi from the nearest septic field.

During 1991, water samples from 99 wells and 3 springs were analyzed for nitrate concentrations. Nitrate concentrations were equal to or exceeded 10 mg/L in water samples from 23 wells (23 percent of the wells samples) and 1 spring (table 4). Nitrate concentrations were equal to or exceeded the analytical detection limit in water samples from 80 wells (80 percent of the wells sampled) and 2 springs. Nitrate concentrations were less than the analytical detection limit in water samples from 19 wells and 1 spring.

During 1991, water samples from 22 wells were analyzed for nutrients and $\delta^{15}N$. Dissolved ammonia concentrations ranged from less than 0.01 to 0.86 mg/L. Dissolved nitrite concentrations ranged from less than 0.01 to 0.83 mg/L. Dissolved nitrate concentrations ranged from 0.92 to 68 mg/L. Dissolved orthophosphate concentrations ranged from less than 0.01 to 0.82 mg/L. The $\delta^{15}N$ values ranged from +4.2 to +29.2 per mil with a mean of +19.2 per mil (table 4).

The mean well depth was 37 ft for wells with water samples having nitrate concentrations greater than 10 mg/L (table 5). The mean well depth was 94 ft for wells with nitrate concentrations less than the analytical detection limit. The mean well diameter was 50 in. for wells with water samples having nitrate concentrations equal to or greater than the analytical detection limit. The mean well diameter was 21 in. for wells with water samples having nitrate concentrations less than the analytical detection limit.

Thirty-two wells with water samples having nitrate concentrations equal to or greater than the analytical detection limit were less than 0.25 mi from the chemical-mixing area, and 40 wells were more than 0.25 mi from the mixing area. The average percentage of row crops within 0.25 mi of the wells with water samples having nitrate concentrations equal to or greater than the analytical detection limit was 29.6 percent. The average percentage of row crops within 0.25 mi of the wells with water samples having nitrate concentrations less than the analytical detection limit was 26.3 percent. Twenty-five of the wells with nitrate concentrations in water samples equal to or greater than the analytical detection limit were less than 100 ft from the nearest feedlot. Seventy-one wells with water samples having nitrate concentrations equal to or greater than the analytical detection limit were less than 0.25 mi from the nearest septic field.

Of the 22 samples analyzed for $\delta^{15}N$, 19 had nitrate concentrations equal to or greater than 10 mg/L (table 4). Twenty samples had $\delta^{15}N$ values greater than +10 per mil. The $\delta^{15}N$ values were greater than +10 per mil for 13 of the wells less than 100 ft from a feedlot (table 5). Kreitler (1975) states that $\delta^{15}N$ values greater than +10 per mil indicate an animal-waste source of nitrate.

SELECTED TRACE-ELEMENT AND RADIONUCLIDE CONCENTRATIONS AND PHYSICAL PROPERTIES OF GROUND WATER AND SPRINGS

During 1990, water samples from 120 wells and 2 springs were analyzed for alpha and beta radiation concentrations. The detection limits for alpha and beta radiation were 1.0 pCi/L. Alpha radiation concentrations in water samples ranged from less than 1.0 to 38 pCi/L (table 6, at the back of this report). Alpha radiation concentrations were equal to or greater than 1.0 pCi/L in water samples from 72 wells and 2 springs. Beta radiation concentrations in water samples ranged from less than 1.0 to 110 pCi/L. Beta radiation concentrations were equal to or greater than 1.0 pCi/L in water samples from 117 wells and 2 springs.

During 1991, total recoverable for selected trace-elements concentrations were determined in water samples from 97 wells and 3 springs. Water samples from 5 wells and 1 spring had arsenic concentrations equal to or greater than 5 µg/L (table 6). Arsenic concentrations in water samples ranged from less than 5 to 10 µg/L. Iron concentrations of water samples from 85 wells and 3 springs were equal to or greater than 100 µg/L (table 6). Iron concentrations in water samples ranged from less than 50 to 8,600 µg/L. Manganese concentrations in water samples from 68 wells and 2 springs were equal to or greater than 20 µg/L and ranged from less than 20 to 7,800 µg/L (table 6).

During 1990, the specific conductance of water samples from 120 wells and 3 springs ranged from 95 to 4,050 µS/cm (microsiemens per centimeter at 25 °C, table 6). The pH values of water samples from 86 wells and 1 spring ranged from 4.7 to 8.3. The temperature of water from 83 wells and 2 springs ranged from 14.0 to 29.0 °C.

During 1991, the specific conductance of water samples from 101 wells and 3 springs ranged from 88 to 3,750 µS/cm (table 6). The pH values of water samples from 23 wells ranged from 5.4 to 7.7. The temperature of water from 85 wells and 3 springs ranged from 7.5 to 29.0 °C.

SUMMARY

During 1990, water samples from wells, springs, and surface-water sites in Bates, Cass, St.Clair, and Vernon Counties in west-central Missouri were analyzed for pesticides, nitrite plus nitrate, alpha and beta radiation, specific conductance, pH, and temperature. During 1991, water samples from sites in Bates, Cass, and Vernon Counties were resampled and analyzed for pesticides, tritium, nutrients, $\delta^{15}N$, arsenic, iron, manganese, specific conductance, pH, and temperature. Selected land-use data also were collected for the sites sampled during 1990 and 1991.

During 1990, one or more of the following pesticides, alachlor, atrazine, cyanazine, desethylatrazine, deisopropylatrazine, metolachlor, metribuzin, prometon, propazine, or simazine, was detected in water samples from 29 of the 92 wells and the 5 surface-water sites. Atrazine was the most commonly detected pesticide. Atrazine concentrations from five wells and two surface-water sites exceeded 3.0 µg/L. However, three of the wells with atrazine concentrations exceeding 3.0 µg/L had water from a surface impoundment added to the well.

During 1991, one or more of the following pesticides, alachlor, atrazine, cyanazine, desethylatrazine, deisopropylatrazine, metolachlor, metribuzin, prometon, propazine, or simazine, was detected in water samples from 27 wells. Atrazine was the most commonly detected pesticide. Atrazine concentrations from one well exceeded 3.0 µg/L. Three of the wells with atrazine concentrations exceeding 0.05 µg/L had water from a surface impoundment added to the well.

During 1991, water samples from 20 wells were analyzed for tritium concentrations. Tritium concentrations were less than or equal to 6.4 pCi/L in water samples from three wells. One of the wells with a tritium concentration of less than 6.4 pCi/L also had pesticides detected in the water sample.

During 1990, nitrate concentrations exceeded 10 mg/L in water from 21 of 89 wells sampled. Nitrate concentrations were equal to or greater than 0.05 mg/L in water samples from 66 wells. No water samples from St. Clair County had nitrate concentrations exceeding 10 mg/L.

During 1991, nitrate concentrations exceeded 10 mg/L in water from 23 of the 99 wells and 1 of the 3 springs sampled. Nitrate concentrations were equal to or greater than the analytical detection limit in water samples from 80 wells and 1 spring. Values of $\delta^{15}N$ of nitrate in water was greater than +10 per mil in 20 of the 22 wells sampled and ranged from +4.2 to +29.2 per mil. The $\delta^{15}N$ values were greater than +10 per mil for 13 of the wells less than 100 ft from a feedlot area. The mean $\delta^{15}N$ value was +19.2 per mil.

During 1990, water samples from 120 wells and 2 springs were analyzed for concentrations of alpha and beta radiation. Alpha radiation concentrations were equal to or greater than 1.0 pCi/L in water samples from 72 wells and 2 springs. Beta radiation concentrations were greater than 1.0 pCi/L in water samples from 117 wells and 2 springs.

During 1991, water samples from 97 wells and 3 springs were analyzed for total recoverable arsenic, iron, and manganese concentrations. Arsenic concentrations were equal to or greater than 5 µg/L in water samples from 5 wells and 1 spring. Iron concentrations were equal to or greater than 100 µg/L in water samples from 85 wells and 3 springs. Manganese concentrations were equal to or greater than 20 µg/L in water samples from 68 wells and 2 springs.

During 1990, the specific conductance of water samples ranged from 95 to 4,050 µS/cm. The pH value of water samples ranged from 4.7 to 8.3. The temperature of water samples ranged from 14.0 to 29.0 °C.

During 1991, the specific conductance of water samples ranged from 88 to 3,750 µS/cm. The pH value of water samples ranged from 5.4 to 7.7. The temperature of water samples ranged from 14.0 to 29.0 °C.

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Tables

Table 1–Location, description, and land-use data for wells, springs, and surface-water sites

[DDMMSS, degrees, minutes, seconds; --, indicates value not determined]

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
Bates County--Wells											
1	7-17-90	380330	0941722	Cherokee Group	32	48	2.5	B	45	C	B
	3-05-91						5.2				
2	7-19-90	380442	0940929	Cherokee Group	28	48	13.4	B	30	B	B
	2-28-91						13.8				
3	7-19-90	380528	0941007	Cherokee Group	17	42	8.8	C	25	C	A
	3-04-91						12.4				
4	7-18-90	380540	0941749	Alluvium	88	6	13.0	--	70	--	--
	3-04-91						--				
5	7-17-90	380609	0942625	Cherokee Group	200	6	--	B	25	C	A
	2-28-91						--				
6	7-16-90	380615	0941640	Cherokee Group	43	60	26.9	A	75	B	B
	2-27-91						27.3				
7	7-18-90	380618	0941311	Cherokee Group	23	48	18.0	--	40	--	--
8	7-17-90	380630	0941616	Cherokee Group	35	48	22.5	C	50	A	B
	2-26-91						23.6				
9	7-18-90	380748	0942512	Cherokee Group	120	8	--	A	25	--	--
	3-04-91						--				
10	7-18-90	380752	0941222	Cherokee Group	29	48	3.5	B	50	B	B
	2-27-91						4.3				
11	7-18-90	380809	0941231	Cherokee Group	16	120	7.0	A	50	A	B
	11-05-90						--				
	2-27-91						7.7				
12	7-18-90	380817	0941234	Cherokee Group	20	54	11.0	B	25	B	B
	11-05-90						--				
	3-04-91						--				
13	7-19-90	380905	0940910	Cherokee Group	17	36	--	C	50	B	B
	2-28-91						6.6				
14	7-18-90	380924	0940835	Pleasanton Group	18	42	10.8	B	75	A	B
	2-28-91						13.1				
15	7-19-90	381004	0940314	Cherokee Group	220	5	--	--	30	A	--
	3-04-91						--				

Table 1–Location, description, and land-use data for wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
Bates County--Wells (Continued)											
16	7-17-90	381115	0942003	Marmaton Group	22	60	--	C	25	A	C
	3-04-91						12.8				
17	7-17-90	381119	0943110	Cherokee Group	200	6	--	--	0	A	B
	3-04-91						--				
18	7-17-90	381150	0941009	Marmaton Group	17	60	5.5	C	50	C	C
	3-04-91						5.0				
19	7-17-90	381157	0942008	Marmaton Group	8.0	48	--	C	15	B	B
	2-27-91						1.6				
20	7-17-90	381213	0942600	Desmoinesian Series	--	36	6.8	B	40	C	A
	2-27-91						--				
21	7-17-90	381400	0943058	Marmaton Group	24	48	8.5	C	10	A	A
	3-05-91						--				
22	7-19-90	381418	0941207	Marmaton Group	52	72	17.1	A	20	B	A
	2-26-91						29.4				
23	7-20-90	381545	0941715	Pleasanton Group	--	8	--	--	20	--	--
	3-06-91						--				
24	7-18-90	381620	0941943	Marmaton Group	46	72	--	A	20	A	B
	2-26-91						13.8				
25	7-19-90	381626	0943518	Marmaton Group	22.8	60	--	A	0	A	B
26	7-19-90	381801	0943156	Marmaton Group	18.8	48	--	C	50	C	A
	3-05-91						9.2				
27	7-18-90	381931	0942609	Pleasanton Group	18.4	60	9.1	B	50	A	A
	3-05-91						14.2				
28	7-19-90	381943	0942722	Marmaton Group	120	6	--	C	0	B	B
	3-05-91						--				
29	7-19-90	382132	0942515	Pleasanton Group	100	6	--	C	25	C	A
	3-05-91						--				
30	7-18-90	382133	0941624	Marmaton Group	180	--	--	C	50	C	--
	3-06-91						--				

Table 1--Location, description, and land-use data for wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
Bates County--Wells (Continued)											
31	7-19-90	382445	0942142	Marmaton Group	100	6	--	C	50	A	B
	3-04-91						--				
32	7-19-90	382537	0942607	Marmaton Group	47	8	--	C	50	C	--
	3-06-91						--				
33	7-18-90	382622	0940850	Desmoinesian Series	27.2	60	3.5	B	0	A	B
	2-27-91						--				
34	7-18-90	382643	0941922	Marmaton Group	54	6	--	C	50	A	B
	3-04-91						27.9				
35	7-18-90	382647	0941540	Marmaton Group	14.1	120	.3	C	0	B	--
36	7-18-90	382717	0942009	Marmaton Group	42	6	--	C	75	A	A
	3-04-91						18.7				
37	7-19-90	382816	0942514	Pleasanton Group	30	48	--	C	0	B	B
	3-04-91						--				
38	7-19-90	382826	0942949	Pleasanton Group	22.5	72	1.6	C	75	C	B
	2-27-91						1.8				
Bates County--Spring											
1	7-17-90	381041	0941950	Marmaton Group	--	--	--	C	25	C	C
	3-04-91						--				
Bates County--Surface-water sites											
1 (Osage River above Schell City)	7-16-90	380320	0940844	--	--	--	--	--	--	--	--
2 (Marais des Cygnes drainage ditch)	7-16-90	380802	0942102	--	--	--	--	--	--	--	--
3	7-19-90	380859	0941809	--	--	--	--	C	50	B	B
4 (Miami Creek near Butler)	7-16-90	381039	0942112	--	--	--	--	--	--	--	--

Table 1–Location, description, and land-use data for wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
Cass County--Wells											
39	7-19-90	382912	0943151	Kansas City Group	35.6	192	--	C	50	B	C
	3-04-91						24.2				
40	7-19-90	382913	0942554	Marmaton Group	80.0	6	--	C	25	B	B
	3-04-91						--				
41	7-19-90	382921	0941737	Marmaton Group	25.0	4	--	A	25	A	A
	3-05-91						--				
42	7-19-90	382926	0941133	Marmaton Group	22.0	168	4.0	C	20	C	A
	3-05-91						4.8				
43	7-19-90	382936	0940710	Marmaton Group	38.0	72	14.7	A	40	B	B
	2-28-91						15.3				
44	7-19-90	382947	0942901	Kansas City Group	80.0	8	--	C	0	C	A
	11-05-90						--				
	3-04-91						--				
45	7-19-90	383012	0940541	Cherokee Group	50.0	6	5.6	C	50	A	B
	2-28-91						--				
46	7-19-90	383040	0941326	Cherokee Group	15.0	96	--	C	0	C	B
	3-04-91						--				
47	7-19-90	383133	0940938	Marmaton Group	21.0	60	8.1	C	25	B	B
	2-28-91						17.4				
48	7-19-90	383158	0941319	Marmaton Group	21.0	24	--	C	50	C	B
	3-05-91						--				
49	7-19-90	383233	0941433	Marmaton Group	25.0	78	--	C	10	B	B
	3-04-91						--				
50	7-19-90	383235	0942208	Marmaton Group	33.0	6	--	--	50	A	A
	3-04-91						--				
51	7-19-90	383257	0942154	Marmaton Group	36.0	168	7.1	C	35	B	B
	3-05-91						16.0				
52	7-19-90	383438	0942530	Marmaton Group	90.0	6	--	B	0	A	A
	3-04-91						--				
53	7-19-90	383457	0940917	Marmaton Group	13.9	84	8.4	A	25	B	B
	2-28-91						10.5				

Table 1–Location, description, and land-use data for wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
Cass County--Wells (Continued)											
54	7-19-90	383510	0942325	Marmaton Group	120	6	--	C	60	B	B
	3-05-91						--				
55	7-19-90	383609	0942410	Marmaton Group	30.0	96	--	C	10	B	B
	3-04-91						--				
56	7-20-90	383847	0943110	Pleasanton Group	35.7	36	--	C	0	A	C
	3-05-91						11.3				
57	7-19-90	383907	0943511	Kansas City Group	45.0	36	--	B	0	A	B
	3-05-91						--				
58	7-20-90	384015	0941417	Marmaton Group	28.6	48	--	C	95	B	A
	3-07-91						8.3				
59	7-19-90	384245	0942815	Kansas City Group	19.8	168	--	B	0	A	A
	3-07-91						3.1				
60	7-20-90	384340	0942904	Kansas City Group	31.2	30	--	C	0	A	A
	3-07-91						13.2				
61	7-20-90	384352	0941601	Pleasanton Group	125	6	--	C	30	A	A
	2-28-91						--				
62	7-20-90	384433	0940953	Marmaton Group	37.6	48	--	C	0	B	A
	3-07-91						15.0				
63	7-19-90	384648	0941013	Pleasanton Group	24.0	60	--	B	50	A	A
	3-05-91						15.0				
Cass County--Surface-water site											
5 (South Grand River at Archie)	7-19-90	382844	0942003	--	--	--	--	--	--	--	--

Table 1--Location, description, and land-use data for wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
St. Clair County--Wells											
64	7-16-90	375151	0934318	Ordovician System	250	6	--	--	0	A	--
65	7-16-90	375429	0934638	Cherokee Group	10.8	48	1.4	--	0	--	--
66	7-16-90	375711	0935552	Mississippian System	60	6	--	--	40	--	--
67	7-16-90	375809	0933957	Cherokee Group	50	6	--	--	25	--	--
68	7-16-90	380237	0940052	Cherokee Group	69.5	6	13.5	--	50	--	--
69	7-16-90	380253	0940251	Cherokee Group	16.4	60	7.2	--	20	--	--
70	7-16-90	380404	0935616	Cherokee Group	165	6	--	--	0	--	--
71	7-16-90	380431	0935726	Cherokee Group	150	8	--	--	0	A	--
72	7-17-90	380445	0935142	Cherokee Group	128	2	--	--	0	--	--
73	7-17-90	380521	0940046	Cherokee Group	225	6	--	--	50	--	--
74	7-17-90	380736	0935735	Cherokee Group	170	6	--	--	50	B	--
75	7-17-90	380824	0935538	Mississippian System	240	6	71.4	--	50	A	--
	11-07-90						--				
76	7-17-90	380838	0940144	Cherokee Group	260	6	--	--	25	A	--
77	7-17-90	381004	0935521	Mississippian System	310	6	86.6	--	50	B	--
	11-07-90						--				
78	7-19-90	381204	0935832	Cherokee Group	180	8	--	--	0	A	--
Vernon County--Wells											
79	7-17-90	374025	0940857	Cherokee Group	33.0	48	--	A	0	B	A
	2-26-91						--				
80	7-16-90	374036	0941314	Cherokee Group	22.0	48	5.5	C	0	C	B
	2-26-91						--				
81	7-16-90	374046	0941256	Cherokee Group	24.9	48	--	C	0	--	--
	2-26-91						8.5				
82	7-16-90	374201	0941020	Cherokee Group	26.4	48	2.4	--	0	--	--
	2-26-91						4.5				
83	7-16-90	374414	0941514	Cherokee Group	31.6	8	--	C	30	C	B
	2-25-91						--				

Table 1–Location, description, and land-use data for wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
Vernon County--Wells (Continued)											
84	7-16-90	374455	0942148	Cherokee Group	105	6	--	C	10	A	B
	2-26-91						--				
85	7-16-90	374508	0941249	Cherokee Group	25.0	24	--	A	50	C	A
	2-25-91						--				
86	7-17-90	374508	0942255	Cherokee Group	90.0	4	--	C	0	A	B
	2-27-91						--				
87	7-16-90	374609	0942102	Cherokee Group	33.0	48	--	C	0	B	B
	2-25-91						--				
88	7-17-90	374704	0940659	Cherokee Group	29.6	12	5.0	B	0	--	--
	2-25-91						7.9				
89	7-17-90	374708	0940834	Cherokee Group	100	8	--	C	0	B	B
	2-28-91						--				
90	7-16-90	374713	0943304	Cherokee Group	22.0	60	--	B	0	B	B
	2-26-91						--				
91	7-18-90	374747	0942635	Cherokee Group	21.1	60	4.4	C	20	C	A
	2-27-91						8.5				
92	7-18-90	374753	0942841	Cherokee Group	60.0	60	--	--	50	A	--
93	7-18-90	374753	0942844	Cherokee Group	125	6	--	--	50	A	--
94	7-16-90	374810	0940836	Cherokee Group	27.0	72	--	A	0	C	A
	2-25-91						18.8				
95	7-16-90	375044	0943633	Cherokee Group	22.0	60	--	C	0	C	C
	2-25-91						3.5				
96	7-18-90	375123	0943038	Cherokee Group	38.5	48	22.7	B	50	A	B
	2-25-91						27.1				
97	7-16-90	375305	0942506	Cherokee Group	65.0	6	1.6	A	90	B	B
	2-27-91						--				
98	7-16-90	375327	0943457	Cherokee Group	--	36	5.8	B	25	B	B
	2-25-91						9.5				

Table 1–Location, description, and land-use data for wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
Vernon County--Wells (Continued)											
99	7-16-90	375544	0940700	Cherokee Group	28.0	48	--	C	0	C	B
	2-27-91						--				
100	7-17-90	375633	0942949	Cherokee Group	34.0	36	4.8	A	80	A	--
	2-28-91						10.6				
101	7-18-90	375645	0942347	Cherokee Group	28.1	36	4.7	--	80	C	B
	2-25-91						7.9				
102	7-16-90	375732	0940710	Cherokee Group	18.0	60	6.5	C	0	B	B
	2-27-91						--				
103	7-18-90	375733	0943419	Cherokee Group	21.4	36	--	A	25	A	B
	2-25-91						6.6				
104	7-16-90	375804	0941901	Cherokee Group	23.0	8	--	C	50	C	B
	2-26-91						--				
105	7-16-90	375828	0940454	Cherokee Group	26.0	48	--	A	50	C	B
106	2-26-91	375828	0940454	Mississippian System	26.0	48	--	A	50	C	B
107	7-16-90	375832	0942410	Cherokee Group	40.9	60	22.3	A	80	B	--
	2-28-91						--				
108	7-17-90	375834	0942203	Cherokee Group	90.0	8	--	C	0	C	A
	2-26-91						--				
109	7-16-90	375838	0941514	Cherokee Group	15.0	60	--	C	50	C	C
	2-27-91						--				
110	7-17-90	380101	0943439	Marmaton Group	30.0	48	7.8	--	25	B	B
	2-26-91						--				
111	7-19-90	380104	0942335	Cherokee Group	33.6	36	3.6	A	75	--	B
	2-25-91						2.9				
112	7-18-90	380120	0942015	Cherokee Group	20.0	42	--	--	0	B	B
	2-27-91						--				
113	7-16-90	380122	0943033	Marmaton Group	20.0	120	--	B	50	C	A
	2-25-91						--				

Table 1–Location, description, and land-use data for wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Latitude (DDMMSS)	Longitude (DDDMMSS)	Geologic unit (fig. 2)	Well			Distance from chemical-mixing area[a]	Percentage of land area with crops within 0.25 mile of well	Distance from feedlot[a]	Distance from septic system[a]
					Depth (feet)	Diameter (inches)	Water level (feet below land surface)				
Vernon County--Wells (Continued)											
114	7-17-90	380125	0942123	Cherokee Group	20.8	36	--	C	25	B	A
	2-27-91						12.6				
115	7-16-90	380136	0941006	Cherokee Group	43.0	48	--	C	75	A	A
	2-26-91						17.7				
116	7-18-90	380158	0941958	Cherokee Group	60.4	--	27.2	--	30	C	B
	2-26-91						--				
117	7-18-90	380203	0940800	Cherokee Group	240	6	--	C	0	A	B
	2-26-91						--				
118	7-18-90	380210	0940759	Cherokee Group	55.0	6	--	C	0	B	A
	2-26-91						--				
119	7-16-90	380222	0942649	Marmaton Group	--	48	--	--	0	--	--
	2-25-91						--				
120	7-18-90	380224	0941704	Cherokee Group	53.2	48	9.2	C	0	C	B
	2-27-91						24.6				
121	7-16-90	380250	0942648	Marmaton Group	21.0	72	11.9	C	0	A	B
	2-27-91						14.8				
Vernon County--Springs											
2	7-17-90	374338	0940600	Cherokee Group	--	--	--	C	--	B	B
	2-25-91						--				
3	7-17-90	374606	0942102	Cherokee Group	--	--	--	C	0	B	B
	2-25-91						--				
Vernon County--Surface-water sites											
6 (Marmaton River near Nevada)	7-16-90	375507	0942139	--	--	--	--	--	--	--	--
7 (Little Osage River near Horton)	7-16-90	375938	0942207	--	--	--	--	--	--	--	--

[a] A, distance less than 100 feet; B, distance 100 feet to 0.25 mile; and C, distance greater than 0.25 mile.

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites

[USGS, U.S. Geological Survey; <, less than; --, no data; IOWA, University of Iowa Hygienic Laboratory, Ames, Iowa; pesticide concentrations are total recoverable in micrograms per liter; tritium concentrations are total recoverable in picocuries per liter; USGS samples also were analyzed for concentrations of ametryn, terbutryn and all sample concentrations were less than 0.05 microgram per liter; IOWA samples also were analyzed for butylate and all sample concentrations were less than 0.10 microgram per liter]

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Bates County--Wells					
1	7-17-90	32.0	48	USGS	<0.2	--	--	--	--
				IOWA	--	<0.10	<0.10	--	--
	3-05-91			USGS	<.2	--	--	--	--
2	7-19-90	28.4	48	USGS	.5	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-28-91			USGS	.4	.08	<.20	<0.05	<0.05
3	7-19-90	16.9	42	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	.2	.18	<.20	<.05	<.05
4	7-18-90	88.0	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
5	7-17-90	200	6	USGS	1.0	.54	<.20	.19	.06
				IOWA	--	.48	<.10	--	--
	2-28-91			USGS	.3	.22	<.20	.08	<.05
6	7-16-90	43.0	60	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-27-91			USGS	<.2	.09	<.20	<.05	<.05
7	7-18-90	22.8	48	USGS	<.2	--	--	--	--
8	7-17-90	34.8	48	USGS	2.0	<.05	<.05	<.05	<.05
				IOWA	--	<.10	<.10	--	--
	2-26-91			USGS	2.0	<.05	<.20	<.05	<.05
9	7-18-90	120	8	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
10	7-18-90	29.1	48	USGS	3.0	1.6	<.20	2.0	.33
				IOWA	--	3.8	<.10	--	--
	2-27-91			USGS	2.0	.67	<.20	.44	.10

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	Tritium
					Bates County--Wells (Continued)				
1	<0.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	<.2	--	--	--	--	--	--	--	--
2	.5	--	--	--	<0.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.4	0.07	<0.05	<0.05	--	<.05	<.05	<.05	28
3	<.2	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
4	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
5	1.0	<.05	<.05	<.05	<.20	<.05	<.06	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.3	<.05	<.05	<.05	--	<.05	<.05	<.05	32
6	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	.37	<.10	.10	--
	<.2	<.05	<.05	<.05	--	.15	<.05	<.05	16
7	<.2	--	--	--	--	--	--	--	--
8	2.0	1.1	<.05	<.05	<.20	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	2.0	.81	<.05	<.05	--	<.05	<.05	<.05	--
9	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
10	3.0	<.05	<.05	<.05	1.6	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	2.0	<.05	<.05	<.05	--	<.05	<.05	<.05	42

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Bates County--Wells (Continued)					
11	7-18-90	15.8	120	USGS	7	7.3	<0.20	1.3	0.33
				IOWA	--	7.9	<.10	--	--
	11-05-90			IOWA	--	4.7	<.10	--	--
	2-27-91			USGS	5	.09	<.20	<.05	<.05
12	7-18-90	20.0	54	USGS	<.2	--	--	--	--
	11-05-90			IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
13	7-19-90	17.2	36	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-28-91			USGS	<.2	--	--	--	--
14	7-18-90	18.4	42	USGS	.4	.15	<.20	.12	<.05
				IOWA	--	.14	<.10	--	--
	2-28-91			USGS	.6	.16	<.20	.05	<.05
15	7-19-90	220	5	USGS	<.2	--	--	--	--
	3-04-91			USGS	<.2	--	--	--	--
16	7-17-90	22.0	60	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
17	7-17-90	200	6	USGS	3	<.05	<.20	<.05	.11
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	.4	.22	<.20	.07	<.05
				USGS	--	--	--	--	--
18	7-17-90	16.8	60	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
19	7-17-90	8.0	48	USGS	6	5.3	<.20	1.4	.33
				IOWA	--	8.2	<.10	--	--
	2-27-91			USGS	.5	.12	<.20	<.05	<.05
20	7-17-90	--	36	USGS	4	1.6	<.20	.57	.16
				IOWA	--	1.6	<.10	--	--
	2-27-91			USGS	<.2	<.05	<.20	<.05	<.05

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				Tritium
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	
				Bates County--Wells (Continued)					
11	7	<0.05	0.43	<0.05	4.1	<0.05	<0.05	<0.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	--	--	--	--	--	<.10	<.10	<.10	--
	5	<.05	<.05	<.05	--	<.05	<.05	<.05	--
12	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
13	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
14	.4	.10	<.05	<.05	.92	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.6	.23	<.05	<.05	--	<.05	<.05	<.05	55
15	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
16	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
17	3	2.4	<.05	.18	<.20	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.4	<.05	<.05	<.05	--	<.05	<.05	<.05	27
	--	--	--	--	--	--	--	--	26
18	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
19	6	<.05	<.05	<.05	1.6	.98	.18	<.05	--
	--	--	--	--	--	.93	.19	<.10	--
	.5	<.05	<.05	<.05	--	.05	<.05	<.05	--
20	4	<.05	<.05	<.05	<.20	<.05	.27	<.05	--
	--	--	--	--	--	<.10	.13	<.10	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Bates County--Wells (Continued)					
21	7-17-90	24.5	48	USGS	<0.2	--	--	--	--
	3-05-91			USGS	<.2	--	--	--	--
22	7-19-90	51.5	72	USGS	8	5.0	<0.20	1.2	0.35
				IOWA	--	5.3	<.10	--	--
	2-26-91			USGS	.9	.21	<.20	.06	<.05
23	7-20-90	--	8	USGS	<.2	--	--	--	--
	3-06-91			USGS	<.2	--	--	--	--
24	7-18-90	46.4	72	USGS	.6	--	--	--	--
				IOWA	--	.12	<.10	--	--
	2-26-91			USGS	.2	.36	<.20	.37	.12
25	[a]7-19-90	22.8	60	USGS	5	1.5	<.20	.27	.08
				IOWA	--	4.0	<.10	--	--
26	7-19-90	18.8	48	USGS	<.2	--	--	--	--
	3-05-91			USGS	.5	.21	<.20	.07	<.05
27	7-18-90	18.4	60	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-05-91			USGS	.2	3.3	<.20	.43	.10
28	7-19-90	120	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-05-91			USGS	<.2	--	--	--	--
29	7-19-90	100	6	USGS	<.2	--	--	--	--
	3-05-91			USGS	<.2	--	--	--	--
30	7-18-90	180	--	USGS	<.2	--	--	--	--
	3-06-91			USGS	<.2	--	--	--	--
31	7-19-90	100	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
32	7-19-90	47.0	8	USGS	<.2	--	--	--	--
	3-06-91			USGS	<.2	--	--	--	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	Tritium
					Bates County--Wells (Continued)				
21	<0.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
22	8	<0.05	<0.05	<0.05	1.1	0.78	0.21	<0.05	--
	--	--	--	--	--	.70	.12	<.10	--
	.9	<.05	<.05	<.05	--	<.05	<.05	<.05	31
23	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
24	.6	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.2	<.05	<.05	<.05	--	<.05	.11	<.05	29
25	5	<.05	<.05	<.05	7.3	1.1	.89	<.05	--
	--	--	--	--	--	1.1	.85	<.10	--
26	<.2	--	--	--	--	--	--	--	--
	.5	<.05	<.05	<.05	--	<.05	<.05	<.05	--
27	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.2	<.05	.13	<.05	--	<.05	<.05	<.05	--
28	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
29	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
30	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
31	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
32	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Bates County--Wells (Continued)					
33	7-18-90	27.2	60	USGS	0.3	0.08	<0.20	<0.05	<0.05
				IOWA	--	<.10	<.10	--	--
	2-27-91			USGS	<.2	<.05	<.20	<.05	<.05
34	7-18-90	54.0	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
35	7-18-90	14.1	120	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
36	7-18-90	42.0	6	USGS	<.2	--	--	--	--
	3-04-91			USGS	<.2	--	--	--	--
37	7-19-90	30.0	48	USGS	<.2	--	--	--	--
	3-04-91			USGS	<.2	--	--	--	--
38	7-19-90	22.5	72	USGS	10	8.4	<.20	1.2	3.7
				IOWA	--	7.9	<.10	--	--
	2-27-91			USGS	6	.20	<.20	<.05	<.05
				Bates County--Spring					
1	7-17-90	--	--	USGS	<0.2	--	--	--	--
	3-04-91	--	--	USGS	<.2	--	--	--	--
				Bates County--Surface-water sites					
1	7-16-90	--	--	USGS	4	--	--	--	--
2	7-16-90	--	--	USGS	5	--	--	--	--
		--	--	IOWA	--	3.6	<0.01	--	--
	2-28-91	--	--	USGS	2	--	--	--	--
3	7-19-90	--	--	USGS	7	1.9	<.20	0.20	0.07
4	7-16-90	--	--	USGS	4	--	--	--	--
		--	--	IOWA	--	3.4	.18	--	--
		--	--	USGS	4	--	--	--	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				Tritium
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	
					Bates County--Wells (Continued)				
33	0.3	<0.05	<0.05	<0.05	<0.20	<0.05	<0.05	<0.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
34	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
35	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
36	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
37	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
38	10	<.05	.08	<.05	<.20	<.05	4.7	<.05	--
	--	--	--	--	--	<.10	4.6	<.10	--
	6	<.05	<.05	<.05	--	<.05	<.05	<.05	25
					Bates County--Spring (Continued)				
1	<0.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
					Bates County--Surface-water sites (Continued)				
1	4	--	--	--	<0.20	--	--	--	--
2	5	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	0.15	0.86	<0.20	--
	2	--	--	--	--	--	--	--	--
3	7	<0.05	<0.05	<0.05	.78	.10	<.05	<.05	--
4	4	--	--	--	--	--	--	--	--
	--	--	--	--	--	.63	.50	.20	--
	4	--	--	--	<.20	--	--	--	--

Table 2–Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Cass County--Wells					
39	7-19-90	35.6	192	USGS	<0.2	--	--	--	--
				IOWA	--	<0.10	<0.10	--	--
	3-04-91			USGS	.2	<.05	<.20	<0.05	<0.05
40	7-19-90	80.0	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	.4	<.05	<.20	<.05	<.05
41	7-19-90	25.0	4	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-05-91			USGS	<.2	<.05	<.20	<.05	<.05
42	7-19-90	22.0	168	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-05-91			USGS	<.2	--	--	--	--
43	7-19-90	38.0	72	USGS	.3	--	--	--	--
				IOWA	--	.20	<.10	--	--
	2-28-91			USGS	<.2	<.05	<.20	<.05	<.05
44	7-19-90	80.0	8	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
45	7-19-90	50.0	6	USGS	<.2	--	--	--	--
				IOWA	--	.26	<.10	--	--
	2-28-91			USGS	2	.49	<.20	.11	<.05
46	7-19-90	15.0	96	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	.4	<.05	<.20	<.05	<.05
47	7-19-90	21.0	60	USGS	.9	<.05	<.20	<.05	<.05
				IOWA	--	<.10	<.10	--	--
	2-28-91			USGS	2	.55	<.20	.12	<.05
48	[a]7-19-90	21.0	24	USGS	.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-05-91			USGS	1	.58	<.20	.12	<.05

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachior	Metolachior	Metribuzin	Tritium
					Cass County--Wells (Continued)				
39	<0.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	.2	<0.05	<0.05	<0.05	--	<.05	<.05	<.05	--
40	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.4	<.05	<.05	<.05	--	<.05	<.05	<.05	--
41	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
42	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
43	.3	--	--	--	0.34	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	34
44	<.2	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
45	<.2	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	2	<.05	<.05	<.05	--	<.05	<.05	<.05	35
46	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.4	<.05	<.05	<.05	--	<.05	<.05	<.05	--
47	.9	.60	<.05	<.05	<.20	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	2	.10	<.05	<.05	--	<.05	<.05	<.05	--
48	.2	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	1	<.05	<.05	<.05	--	<.05	<.05	<.05	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Cass County--Wells (Continued)					
49	7-19-90	25	78	USGS	<0.2	--	--	--	--
				IOWA	--	<0.10	<0.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
50	7-19-90	33	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
51	7-19-90	36	168	USGS	.3	--	--	--	--
				IOWA	--	.13	<.10	--	--
	3-05-91			USGS	.2	.24	<.20	<0.05	<0.05
52	7-19-90	90	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
53	7-19-90	13.9	84	USGS	.2	--	--	--	--
				IOWA	--	.10	<.10	--	--
	2-28-91			USGS	1	.82	<.20	.19	<.05
54	7-19-90	120	6	USGS	.3	.09	<.20	<.05	<.05
				IOWA	--	.10	<.10	--	--
	3-05-91			USGS	<.2	.25	<.20	<.05	<.05
55	7-19-90	30	96	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	3-04-91			USGS	<.2	--	--	--	--
56	7-20-90	35.7	36	USGS	<.2	--	--	--	--
	3-05-91			USGS	<.2	<.05	<.20	<.05	<.05
57	7-19-90	45	36	USGS	1	.38	<.20	.38	<.05
				IOWA	--	.29	<.10	--	--
				IOWA	--	.31	<.10	--	--
	3-05-91			USGS	.8	.30	<.20	.20	<.05
				USGS	--	--	--	--	--
58	7-20-90	28.6	48	USGS	<.2	--	--	--	--
	3-07-91			USGS	<.2	<.05	<.20	<.05	<.05

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				Tritium
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	
					Cass County--Wells (Continued)				
49	<0.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	<.2	--	--	--	--	--	--	--	--
50	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
51	.3	--	--	--	<0.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.2	<0.05	<0.05	<0.05	--	<.05	<.05	<.05	--
52	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
53	.2	--	--	--	.26	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	1	<.05	<.05	<.05	--	<.05	<.05	<.05	--
54	.3	<.05	<.05	<.05	<.20	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
55	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
56	<.2	--	--	--	--	--	--	--	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
57	1	<.05	<.05	<.05	<.20	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.8	<.05	<.05	<.05	--	<.05	<.05	<.05	84
	--	--	--	--	--	--	--	--	72
58	<.2	--	--	--	--	--	--	--	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Cass County--Wells (Continued)					
59	7-19-90	19.8	168	USGS	<0.2	--	--	--	--
				IOWA	--	<0.10	<0.10	--	--
				IOWA	--	<.10	<.10	--	--
	3-07-91			USGS	<.2	<.05	<.20	<0.05	<0.05
60	7-20-90	31.2	30	USGS	<.2	--	--	--	--
	3-07-91			USGS	<.2	--	--	--	--
61	7-20-90	125	6	USGS	.4	--	--	--	--
	2-28-91			USGS	1	<.05	<.20	<.05	<.05
62	7-20-90	37.6	48	USGS	.7	<.05	<.20	<.05	<.05
	3-07-91			USGS	<.2	<.05	<.20	<.05	<.05
63	7-19-90	24	60	USGS	.5	.21	<.20	.13	<.05
				IOWA	--	.19	<.10	--	--
	3-05-91			USGS	.3	.17	<.20	.10	<.05
64	7-16-90	250	6	USGS	<.2	--	--	--	--
65	7-16-90	10.8	48	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
66	7-16-90	60	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
67	7-16-90	50	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
68	7-16-90	69.5	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
69	7-16-90	16.4	60	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
70	7-16-90	165	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
71	7-16-90	150	8	USGS	<.2	--	--	--	--
72	7-17-90	128	2	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	Tritium
					Cass County--Wells (Continued)				
59	<0.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	<0.05	<0.05	<0.05	--	<.05	<.05	<.05	--
60	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
61	.4	--	--	--	--	--	--	--	--
	1	<.05	<.05	<.05	--	<.05	<.05	<.05	2.0
62	.7	<.05	<.05	<.05	<0.20	<.05	<.05	<.05	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
63	.5	<.05	<.05	<.05	<.20	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.3	<.05	<.05	<.05	--	<.05	<.05	<.05	--
64	<.2	--	--	--	--	--	--	--	--
65	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
66	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
67	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
68	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
69	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
70	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
71	<.2	--	--	--	--	--	--	--	--
72	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Cass County--Surface-water site					
5	7-19-90	--	--	USGS	1	--	--	--	--
		--	--	USGS	.7	--	--	--	--
		--	--	IOWA	--	0.60	<0.10	--	--
	2-28-91	--	--	USGS	.8	--	--	--	--
				St. Clair County--Wells					
73	7-17-90	225	6	USGS	<0.2	--	--	--	--
				IOWA	--	<0.10	<0.10	--	--
74	7-17-90	170	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
75	7-17-90	240	6	USGS	<.2	--	--	--	--
76	7-17-90	260	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
77	7-17-90	310	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
78	7-19-90	180	8	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
				Vernon County--Wells					
79	7-17-90	33	48	USGS	<0.2	--	--	--	--
	2-26-91			USGS	<.2	--	--	--	--
80	7-16-90	22	48	USGS	<.2	--	--	--	--
				IOWA	--	<.0.10	<0.10	--	--
	2-26-91			USGS	<.2	--	--	--	--
81	7-16-90	24.9	48	USGS	<.2	--	--	--	--
				IOWA	--	.21	<.10	--	--
	2-26-91			USGS	.2	<.05	<.20	<0.05	<0.05
82	7-16-90	26.4	48	USGS	<.2	--	--	--	--
	2-26-91			USGS	<.2	<.05	<.20	<.05	<.05
83	7-16-90	31.6	8	USGS	<.2	--	--	--	--
	2-25-91			USGS	<.2	--	<.10	--	--

Table 2–Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	Tritium
					Cass County--Surface-water site (Continued)				
5	1	--	--	--	<0.20	--	--	--	--
	.7	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	.8	--	--	--	--	--	--	--	--
					St. Clair County--Wells (Continued)				
73	<0.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
74	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
75	<.2	--	--	--	--	--	--	--	--
76	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
77	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
78	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
					Vernon County--Wells (Continued)				
79	<0.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
80	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	<.2	--	--	--	--	--	--	--	--
81	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.2	<0.05	<0.05	<0.05	--	<.05	<.05	<.05	--
82	<.2	--	--	--	--	--	--	--	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
83	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Vernon County--Wells (Continued)					
84	7-16-90	105	6	USGS	<0.2	--	--	--	--
	2-26-91			USGS	<.2	--	--	--	--
85	7-16-90	25.0	24	USGS	<.2	--	--	--	--
				IOWA	--	<0.10	<0.10	--	--
	2-25-91			USGS	<.2	--	--	--	--
86	7-17-90	90.0	4	USGS	<.2	--	--	--	--
	2-27-91			USGS	<.2	--	--	--	--
87	7-16-90	33.0	48	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-25-91			USGS	<.2	--	--	--	--
88	7-17-90	29.6	12	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-25-91			USGS	<.2	--	--	--	--
89	7-17-90	100	8	USGS	<.2	--	--	--	--
	2-28-91			USGS	<.2	--	--	--	--
90	7-16-90	22.0	60	USGS	.5	--	--	--	--
				IOWA	--	.20	<.10	--	--
	2-26-91			USGS	2	.68	<.20	0.27	<0.05
91	7-18-90	21.1	60	USGS	<.2	--	--	--	--
	2-27-91			USGS	<.2	--	--	--	--
92	7-18-90	60.0	60	USGS	<.2	--	--	--	--
93	7-18-90	125	6	USGS	<.2	--	--	--	--
94	7-16-90	27.0	72	USGS	<.2	--	--	--	--
	2-25-91			USGS	<.2	--	--	--	--
95	7-16-90	22.0	60	USGS	<.2	<.05	<.20	<.05	<.05
	2-25-91			USGS	<.2	<.05	<.20	<.05	<.05
96	7-18-90	38.5	48	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-25-91			USGS	.2	<.05	<.20	<.05	<.05

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	Tritium
					Vernon County--Wells (Continued)				
84	<0.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
85	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	<.2	--	--	--	--	--	--	--	--
86	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
87	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
88	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
89	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
90	.5	--	--	--	0.30	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	2	<0.05	<0.05	<0.05	--	<.05	<.05	<.05	6.0
91	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
92	<.2	--	--	--	--	--	--	--	--
93	<.2	--	--	--	--	--	--	--	--
94	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
95	<.2	<.05	<.05	<.05	<.20	<.05	<.05	<.05	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
96	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--

Table 2–Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Vernon County--Wells (Continued)					
97	7-16-90	65.0	6	USGS	0.6	--	--	--	--
				IOWA	--	0.14	<0.10	--	--
	2-27-91			USGS	<.2	<.05	<.20	<0.05	<0.05
98	7-16-90	--	36	USGS	<.2	--	--	--	--
	2-25-91			USGS	<.2	--	--	--	--
99	7-16-90	28.0	48	USGS	<.2	--	--	--	--
	2-27-91			USGS	<.2	--	--	--	--
100	7-17-90	34.0	36	USGS	1	.51	<.20	.23	.11
				IOWA	--	.46	<.10	--	--
	2-28-91			USGS	.8	.33	<.20	.07	<.05
101	7-18-90	28.1	36	USGS	.6	.26	<.20	.18	<.05
				IOWA	--	.25	<.10	--	--
	2-25-91			USGS	.3	.10	<.20	.06	<.05
102	7-16-90	18.0	60	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-27-91			USGS	<.2	--	--	--	--
103	7-18-90	21.4	36	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-25-91			USGS	<.2	<.05	<.20	<.05	<.05
104	7-16-90	23.0	8	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-26-91			USGS	.2	--	--	--	--
105	7-16-90	26.0	48	USGS	.3	<.05	<.20	<.05	<.05
				IOWA	--	<.10	<.10	--	--
106	2-26-91	26.0	48	USGS	<.2	<.05	<.20	<.05	<.05

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				Tritium
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	
					Vernon County--Wells (Continued)				
97	0.6	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	<.2	<0.05	<0.05	<0.05	--	<.05	<.05	<.05	9.0
98	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
99	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
100	1	<.05	<.05	<.05	0.58	.10	.06	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.8	<.05	<.05	<.05	--	<.05	<.05	.09	27
101	.6	<.05	<.05	<.05	<.20	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.3	<.05	<.05	<.05	--	<.05	<.05	<.05	40
102	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
103	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
104	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.2	--	--	--	--	--	--	--	--
105	.3	<.05	<.05	<.05	<.20	<.05	<.05	<.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
106	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--

Table 2–Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
				Vernon County--Wells (Continued)					
107	7-16-90	40.9	60	USGS	<0.2	--	--	--	--
				IOWA	--	<0.10	<0.10	--	--
	2-28-91			USGS	<.2	--	--	--	--
108	7-17-90	90.0	8	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-26-91			USGS	<.2	--	--	--	--
109	7-16-90	15.0	60	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-27-91			USGS	<.2	--	--	--	--
110	7-17-90	30.0	48	USGS	<.2	--	--	--	--
	2-26-91			USGS	<.2	--	--	--	--
111	7-19-90	33.6	36	USGS	.5	--	--	--	--
				IOWA	--	.20	<.10	--	--
	2-25-91			USGS	<.2	--	--	--	--
112	7-18-90	20.0	42	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-27-91			USGS	<.2	--	--	--	--
113	7-16-90	20.0	120	USGS	.2	--	--	--	--
				IOWA	--	.10	<.10	--	--
	2-25-91			USGS	<.2	<.05	<.20	<0.05	<0.05
114	7-17-90	20.8	36	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-27-91			USGS	<.2	--	--	--	--
115	7-16-90	43.0	48	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-26-91			USGS	<.2	--	--	--	--
116	7-18-90	60.4	--	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-26-91			USGS	<.2	--	--	--	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	Tritium
					Vernon County--Wells (Continued)				
107	<0.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	<.2	--	--	--	--	--	--	--	--
108	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
109	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
110	<.2	--	--	--	--	--	--	--	--
	<.2	--	--	--	--	--	--	--	--
111	.5	--	--	--	0.84	--	--	--	--
	--	--	--	--	--	.51	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
112	<.2	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
113	.2	--	--	--	.64	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	<0.05	<0.05	<0.05	--	<.05	<.05	<.05	48
114	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
115	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
116	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Triazine herbicides				
					By enzyme assay	Atrazine	Cyanazine	Desethyl-atrazine	Deisopropyl-atrazine
Vernon County--Wells (Continued)									
117	7-18-90	240	6	USGS	2	<0.05	<0.20	<0.05	<0.05
				IOWA	--	<.10	<.10	--	--
	2-26-91			USGS	.9	<.05	<.20	<.05	<.05
118	7-18-90	55.0	6	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-26-91			USGS	<.2	--	--	--	--
119	7-16-90	--	48	USGS	.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-25-91			USGS	<.2	<.05	<.20	<.05	<.05
120	7-18-90	53.2	48	USGS	<.2	--	--	--	--
				IOWA	--	<.10	<.10	--	--
	2-27-91			USGS	<.2	--	--	--	--
121	7-16-90	21.0	72	USGS	<.2	--	--	--	--
	2-27-91			USGS	.5	.23	<.20	<.05	<.05
Vernon County--Springs									
2	7-17-90	--	--	USGS	<0.2	--	--	--	--
		--	--	IOWA	--	<0.10	<0.10	--	--
	2-25-91	--	--	USGS	<.2	--	--	--	--
3	7-17-90	--	--	USGS	<.2	--	--	--	--
		--	--	IOWA	--	<.10	<.10	--	--
	2-25-91	--	--	USGS	<.2	--	--	--	--
Vernon County--Surface-water sites									
6	7-16-90	--	--	USGS	1	--	--	--	--
7	7-16-90	--	--	USGS	2	--	--	--	--
		--	--	IOWA	--	1.6	<0.10	--	--

Table 2--Pesticide and tritium concentrations in water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Triazine herbicides--Continued				Cl-actemide herbicides				Tritium
	By enzyme assay	Prometon	Propazine	Simazine	By enzyme assay	Alachlor	Metolachlor	Metribuzin	
					Vernon County--Wells (Continued)				
117	2	<0.05	<0.05	<0.05	<0.20	<.0.05	<0.05	<0.05	--
	--	--	--	--	--	<.10	<.10	<.10	--
	.9	<.05	<.05	<.05	--	<.05	<.05	<.05	<1.0
118	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	30
119	.2	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	<.05	<.05	<.05	--	<.05	<.05	<.05	--
120	<.2	--	--	--	<.20	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
121	<.2	--	--	--	--	--	--	--	--
	.5	<.05	<.05	<.05	--	<.05	<.05	<.05	--
					Vernon County--Springs (Continued)				
2	<0.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--
	<.2	--	--	--	--	--	--	--	--
3	<.2	--	--	--	--	--	--	--	--
	--	--	--	--	--	<.10	<.10	<.10	--
	<.2	--	--	--	--	--	--	--	--
					Vernon County--Surface-water sites (Continued)				
6	1	--	--	--	<0.20	--	--	--	--
7	2	--	--	--	--	<.20	--	--	--
	--	--	--	--	--	<0.10	<0.10	<0.10	--

[a] Indicates surface water added to well.

Table 4--Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs

[All concentrations in milligrams per liter, except $\delta^{15}N$ values, which are in per mil relative to atmospheric standard; DOH, sample analyzed by the Department of Health laboratory, Jefferson City, Missouri; USGS, sample analyzed by a U.S. Geological Survey laboratory; --, missing data; <, less than]

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Bates County--Wells						
1	3-05-91	32.0	48	DOH	7.7	--	--	--	--	--
2	7-19-90	28.4	48	USGS	20	--	--	--	--	--
	2-28-91			USGS	--	0.03	<0.01	14	0.06	14.3
				DOH	15	--	--	--	--	--
				USGS	--	--	--	--	--	13.7
3	7-19-90	16.9	42	USGS	<.10	--	--	--	--	--
	3-04-91			DOH	.10	--	--	--	--	--
4	7-18-90	88.0	6	USGS	<.10	--	--	--	--	--
	3-04-91			DOH	<.05	--	--	--	--	--
5	2-28-91	200	6	DOH	1.5	--	--	--	--	--
6	7-16-90	43.0	60	DOH	.09	--	--	--	--	--
7	7-18-90	22.8	48	DOH	3.7	--	--	--	--	--
8	2-26-91	34.8	48	DOH	1.3	--	--	--	--	--
9	7-18-90	120	8	USGS	<.10	--	--	--	--	--
	3-04-91			DOH	<.05	--	--	--	--	--
10	7-18-90	29.1	48	USGS	.60	--	--	--	--	--
	2-27-91			DOH	3.5	--	--	--	--	--
11	7-18-90	15.8	120	USGS	25	--	--	--	--	--
	2-27-91			USGS	--	.86	.83	17	.82	25.0
				DOH	17	--	--	--	--	--
12	7-18-90	20.0	54	USGS	.60	--	--	--	--	--
	11-05-90			DOH	.24	--	--	--	--	--
	3-04-91			DOH	.40	--	--	--	--	--

Table 4--Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Bates County--Wells (Continued)						
13	7-19-90	17.2	36	USGS	15	--	--	--	--	--
	2-28-91			USGS	--	<0.01	<0.01	14	0.05	22.6
				DOH	14	--	--	--	--	--
14	7-18-90	18.4	42	USGS	36	--	--	--	--	--
	2-28-91			USGS	--	.01	<.01	47	.01	16.3
				DOH	53	--	--	--	--	--
				USGS	--	--	--	--	--	22.3
15	7-19-90	220	5	USGS	<.10	--	--	--	--	--
	3-04-91			DOH	<.05	--	--	--	--	--
16	7-17-90	22.0	60	DOH	23	--	--	--	--	--
	3-04-91			USGS	--	.06	<.01	20	.10	4.2
				DOH	21	--	--	--	--	--
17	7-17-90	200	6	DOH	13	--	--	--	--	--
	3-04-91			USGS	--	.02	<.01	.92	<.01	9.2
				DOH	.87	--	--	--	--	--
18	3-04-91	16.8	60	DOH	2.1	--	--	--	--	--
19	2-27-91	8.0	48	DOH	.33	--	--	--	--	--
20	2-27-91	--	36	DOH	.20	--	--	--	--	--
21	3-05-91	24.5	48	DOH	3.4	--	--	--	--	--
22	7-19-90	51.5	72	USGS	1.1	--	--	--	--	--
	2-26-91			DOH	1.6	--	--	--	--	--
23	7-20-90	--	8	USGS	.40	--	--	--	--	--
	3-06-91	--		DOH	<.05	--	--	--	--	--
24	7-18-90	46.4	72	USGS	5.7	--	--	--	--	--
	2-26-91			DOH	8.4	--	--	--	--	--
25	[a]7-19-90	22.8	60	USGS	7.7	--	--	--	--	--

Table 4–Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Bates County--Wells (Continued)						
26	7-19-90	18.8	48	USGS	2.6	--	--	--	--	--
	3-05-91			DOH	1.4	--	--	--	--	--
27	7-18-90	18.4	60	USGS	5.0	--	--	--	--	--
	3-05-91			DOH	1.5	--	--	--	--	--
28	7-19-90	120	6	USGS	<.10	--	--	--	--	--
	3-05-91			DOH	<.05	--	--	--	--	--
29	7-19-90	100	6	USGS	.20	--	--	--	--	--
	3-05-91			DOH	<.05	--	--	--	--	--
30	7-18-90	180	--	USGS	<.10	--	--	--	--	--
	3-06-91			DOH	<.05	--	--	--	--	--
31	7-19-90	100	6	USGS	34	--	--	--	--	--
	3-04-91			USGS	--	<0.01	0.01	49	<0.01	17.2
				DOH	46	--	--	--	--	--
32	7-19-90	47.0	8	USGS	7.2	--	--	--	--	--
	3-06-91			DOH	3.8	--	--	--	--	--
33	7-18-90	27.2	60	USGS	.70	--	--	--	--	--
	2-27-91			DOH	4.0	--	--	--	--	--
34	7-18-90	54.0	6	USGS	8.5	--	--	--	--	--
	3-04-91			DOH	9.9	--	--	--	--	--
35	7-18-90	14.1	120	USGS	15	--	--	--	--	--
36	7-18-90	42.0	6	USGS	14	--	--	--	--	--
	3-04-91			USGS	--	.02	.02	25	.02	16.9
				DOH	24	--	--	--	--	--
37	7-19-90	30.0	48	USGS	6.7	--	--	--	--	--
	3-04-91			DOH	8.6	--	--	--	--	--

Table 4–Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Bates County–Wells (Continued)						
38	7-19-90	22.5	72	USGS	1.2	--	--	--	--	--
	2-27-91			DOH	.17	--	--	--	--	--
				Bates County–Spring						
1	3-04-91	--	--	DOH	<0.05	--	--	--	--	--
				Cass County–Wells						
39	7-19-90	35.6	192	USGS	1.3	--	--	--	--	--
	3-04-91			DOH	2.9	--	--	--	--	--
40	7-19-90	80.0	6	USGS	7.7	--	--	--	--	--
	3-04-91			DOH	8.5	--	--	--	--	--
41	7-19-90	25.0	4	USGS	21	--	--	--	--	--
	3-05-91			USGS	--	0.01	<0.01	8.0	0.12	20.0
				DOH	7.9	--	--	--	--	--
42	7-19-90	22.0	168	USGS	2.0	--	--	--	--	--
	3-05-91			DOH	1.4	--	--	--	--	--
43	7-19-90	38.0	72	USGS	4.8	--	--	--	--	--
	2-28-91			DOH	3.9	--	--	--	--	--
44	7-19-90	80.0	8	USGS	.70	--	--	--	--	--
	3-04-91			DOH	.35	--	--	--	--	--
45	7-19-90	50.0	6	USGS	.30	--	--	--	--	--
	2-28-91			DOH	1.3	--	--	--	--	--
46	7-19-90	15.0	96	USGS	1.5	--	--	--	--	--
	3-04-91			DOH	.58	--	--	--	--	--
47	7-19-90	21.0	60	USGS	<.10	--	--	--	--	--
	2-28-91			DOH	.74	--	--	--	--	--
48	[a]7-19-90	21.0	24	USGS	18	--	--	--	--	--

Table 4--Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Cass County--Wells (Continued)						
49	7-19-90	25.0	78	USGS	6.5	--	--	--	--	--
	3-04-91			DOH	7.0	--	--	--	--	--
50	7-19-90	33.0	6	USGS	3.2	--	--	--	--	--
	3-04-91			DOH	4.0	--	--	--	--	--
51	7-19-90	36.0	168	USGS	6.9	--	--	--	--	--
	3-05-91			USGS	--	0.02	<0.01	22	0.35	17.2
				DOH	21	--	--	--	--	--
52	7-19-90	90.0	6	USGS	<.10	--	--	--	--	--
	3-04-91			DOH	<.05	--	--	--	--	--
53	7-19-90	13.9	84	USGS	1.4	--	--	--	--	--
	2-28-91			DOH	.59	--	--	--	--	--
54	7-19-90	120	6	USGS	<.10	--	--	--	--	--
	3-05-91			DOH	<.05	--	--	--	--	--
55	7-19-90	30.0	96	USGS	7.4	--	--	--	--	--
	3-04-91			DOH	6.0	--	--	--	--	--
56	7-20-90	35.7	36	USGS	.30	--	--	--	--	--
	3-05-91			DOH	.07	--	--	--	--	--
57	7-19-90	45.0	36	USGS	52	--	--	--	--	--
	3-05-91			USGS	--	.10	.07	68	<.01	27.2
				DOH	65	--	--	--	--	--
				USGS	--	--	--	--	--	30.3
58	7-20-90	28.6	48	USGS	38	--	--	--	--	--
	3-07-91			USGS	--	<.01	<.01	35	.02	19.1
59	7-19-90	19.8	168	USGS	17	--	--	--	--	--
	3-07-91			USGS	--	<.01	<.01	11	.82	14.8

Table 4--Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Cass County--Wells (Continued)						
60	7-20-90	31.2	30	USGS	12	--	--	--	--	--
	3-07-91			USGS	--	0.03	<0.01	17	0.03	26.5
61	7-20-90	125	6	USGS	<.10	--	--	--	--	--
	2-28-91			DOH	<.05	--	--	--	--	--
62	7-20-90	37.6	48	USGS	9.2	--	--	--	--	--
	3-07-91			USGS	--	<.01	<.01	6.4	.10	19.6
63	7-19-90	24.0	60	USGS	27	--	--	--	--	--
	3-05-91			USGS	--	<.01	<.01	23	.08	18.9
				DOH	22	--	--	--	--	--
				St. Clair County--Wells						
65	7-16-90	10.8	48	DOH	<0.05	--	--	--	--	--
66	7-16-90	60.0	6	DOH	<.05	--	--	--	--	--
70	7-16-90	165	6	DOH	<.05	--	--	--	--	--
75	11-06-90	240	6	DOH	<.05	--	--	--	--	--
76	7-17-90	260	6	DOH	8.1	--	--	--	--	--
77	11-06-90	310	6	DOH	<.05	--	--	--	--	--
78	7-19-90	180	8	USGS	.90	--	--	--	--	--
				Vernon County--Wells						
79	2-26-91	33.0	48	DOH	6.8	--	--	--	--	--
80	2-26-91	22.0	48	DOH	<.05	--	--	--	--	--
81	2-26-91	24.9	48	DOH	1.3	--	--	--	--	--
				DOH	1.3	--	--	--	--	--
82	7-16-90	26.4	48	DOH	.86	--	--	--	--	--
	2-26-91			DOH	1.9	--	--	--	--	--

Table 4--Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Vernon County--Wells (Continued)						
83	7-16-90	31.6	8	DOH	<0.05	--	--	--	--	--
	2-25-91			DOH	19	--	--	--	--	--
84	2-26-91	105	6	DOH	.18	--	--	--	--	--
85	7-16-90	25.0	24	DOH	2.2	--	--	--	--	--
	2-25-91			DOH	3.8	--	--	--	--	--
86	2-27-91	90.0	4	DOH	<.05	--	--	--	--	--
87	7-16-90	33.0	48	DOH	<.05	--	--	--	--	--
	2-25-91			DOH	.34	--	--	--	--	--
88	2-25-91	29.6	12	DOH	2.4	--	--	--	--	--
89	7-17-90	100	8	DOH	7.1	--	--	--	--	--
	2-28-91			DOH	12	--	--	--	--	--
90	7-16-90	22.0	60	DOH	7.7	--	--	--	--	--
	2-26-91			USGS	--	0.02	<0.01	10	0.06	22.2
				DOH	11	--	--	--	--	--
91	2-27-91	21.1	60	DOH	.06	--	--	--	--	--
92	7-18-90	60.0	60	USGS	<.10	--	--	--	--	--
93	7-18-90	125	6	USGS	<.10	--	--	--	--	--
94	2-25-91	27.0	72	DOH	21	--	--	--	--	--
95	7-16-90	22.0	60	DOH	<.05	--	--	--	--	--
	2-25-91			DOH	<.05	--	--	--	--	--
96	7-18-90	38.5	48	USGS	42	--	--	--	--	--
	2-25-91			USGS	--	<.01	<.01	38	.06	16.1
				DOH	36	--	--	--	--	--
				USGS	--	--	--	--	--	16.4
97	7-16-90	65.0	6	DOH	<.05	--	--	--	--	--
	2-27-91			DOH	<.05	--	--	--	--	--

Table 4–Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Vernon County--Wells (Continued)						
98	7-16-90	--	36	DOH	4.2	--	--	--	--	--
	2-25-91			DOH	4.7	--	--	--	--	--
99	7-16-90	28.0	48	DOH	.11	--	--	--	--	--
	2-27-91			DOH	<.05	--	--	--	--	--
100	2-28-91	34.0	36	DOH	.16	--	--	--	--	--
101	7-18-90	28.1	36	USGS	1.4	--	--	--	--	--
	2-25-91			DOH	4.3	--	--	--	--	--
				DOH	2.5	--	--	--	--	--
102	2-27-91	18.0	60	DOH	6.7	--	--	--	--	--
103	7-18-90	21.4	36	USGS	37	--	--	--	--	--
	2-25-91			USGS	--	0.01	<0.01	18	0.04	29.2
				DOH	20	--	--	--	--	--
104	2-26-91	23.0	8	DOH	36	--	--	--	--	--
106	2-26-91	26.0	48	DOH	<.05	--	--	--	--	--
107	7-16-90	40.9	60	DOH	1.9	--	--	--	--	--
	2-28-91			DOH	.79	--	--	--	--	--
108	7-17-90	90.0	8	DOH	10	--	--	--	--	--
	2-26-91			USGS	--	.01	.07	23	.01	23.8
				DOH	21	--	--	--	--	--
109	2-27-91	15.0	60	DOH	<.05	--	--	--	--	--
110	2-26-91	30.0	48	DOH	2.3	--	--	--	--	--
111	7-19-90	33.6	36	USGS	<.10	--	--	--	--	--
	2-25-91			DOH	.17	--	--	--	--	--
112	7-18-90	20.0	42	USGS	6.5	--	--	--	--	--
	2-27-91			DOH	5.6	--	--	--	--	--

Table 4–Nutrient concentrations and $\delta^{15}N$ values of water samples from wells and springs–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Well diameter (inches)	Agency analyzing sample	Total nitrite plus nitrate as nitrogen	Ammonia, dissolved as nitrogen	Nitrite, dissolved as nitrogen	Nitrite plus nitrate, dissolved as nitrogen	Orthophosphate, dissolved as phosphorus	$\delta^{15}N$ of NO_3 (per mil)
				Vernon County--Wells (Continued)						
113	2-25-91	20.0	120	DOH	0.24	--	--	--	--	--
114	7-17-90	20.8	36	DOH	15	--	--	--	--	--
	2-27-91			USGS	--	<0.01	<0.01	26	0.04	24.2
				DOH	26	--	--	--	--	--
115	7-16-90	43.0	48	DOH	18	--	--	--	--	--
	2-26-91			USGS	--	.03	<.01	24.0	.05	14.4
				DOH	25	--	--	--	--	--
116	7-18-90	60.4	--	USGS	7.0	--	--	--	--	--
	2-26-91			DOH	1.7	--	--	--	--	--
117	7-18-90	240	6	USGS	<.10	--	--	--	--	--
	2-26-91			DOH	<.05	--	--	--	--	--
118	7-18-90	55.0	6	USGS	8.8	--	--	--	--	--
	2-26-91			DOH	9.0	--	--	--	--	--
119	2-25-91	--	48	DOH	.93	--	--	--	--	--
120	7-18-90	53.2	48	USGS	.60	--	--	--	--	--
	2-27-91			DOH	.16	--	--	--	--	--
121	7-16-90	21.0	72	DOH	.08	--	--	--	--	--
	2-27-91			DOH	.39	--	--	--	--	--
				Vernon County--Springs						
2	2-25-91	--	--	DOH	11	--	--	--	--	--
3	7-17-90	--	--	DOH	<.05	--	--	--	--	--
	2-25-91	--	--	DOH	.92	--	--	--	--	--

[a] Indicates surface water added to well.

Table 6–Physical properties and selected trace element and radionuclide concentrations of water samples from wells, springs, and surface-water sites

[Specific conductance in microsiemens per centimeter at 25 degrees Celsius; temperature in degrees Celsius; arsenic, iron, and manganese concentrations are total recoverable in micrograms per liter; alpha radiation in picocuries per liter relative to americium-241; beta radiation in picocuries per liter relative to cesium-137; --, missing data; <, less than]

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
					Bates County--Wells					
1	7-17-90	32.0	244	5.4	--	--	--	--	1.6	1.6
	3-05-91		212	--	--	<5	<50	20	--	--
2	7-19-90	28.4	1,160	6.8	15.5	--	--	--	1.2	5.7
	2-28-91		1,130	6.6	15.0	<5	220	90	--	--
3	7-19-90	16.9	1,980	6.6	15.0	--	--	--	1.4	4.4
	3-04-91		245	--	--	<5	110	<20	--	--
4	7-18-90	88.0	706	7.0	16.0	--	--	--	7.0	7.5
	3-04-91		702	--	15.0	<5	2,000	270	--	--
5	7-17-90	200	696	7.4	19.0	--	--	--	2.1	3.0
	2-28-91		615	--	13.0	--	--	--	--	--
6	7-16-90	43.0	2,230	6.6	18.0	--	--	--	5.1	7.5
	2-27-91		2,340	--	14.0	<5	380	2,200	--	--
7	7-18-90	22.8	825	7.1	15.0	--	--	--	<1.0	7.2
8	7-17-90	34.8	488	7.0	--	--	--	--	<1.0	13
	2-26-91		450	--	12.5	<5	2,400	270	--	--
9	7-18-90	120	1,810	7.9	19.0	--	--	--	<1.0	8.2
	3-04-91		1,920	--	12.0	<5	380	<20	--	--
10	7-18-90	29.1	622	6.9	14.5	--	--	--	1.7	2.8
	2-27-91		680	--	13.0	<5	110	<20	--	--
[a]11	7-18-90	15.8	1,600	6.8	21.5	--	--	--	2.7	110
	11-05-90		--	--	--	--	--	--	4.6	24
	2-27-91		1,280	7.1	8.0	<5	990	70	--	--
12	7-18-90	20.0	782	6.8	14.5	--	--	--	2.6	3.6
	3-04-91		750	--	14.0	<5	660	20	--	--

Table 6–Physical properties and selected trace element and radionuclide concentrations of water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
				Bates County--Wells (Continued)						
13	7-19-90	17.2	1,050	6.4	17.5	--	--	--	<1.0	1.7
	2-28-91		1,040	6.7	9.0	<5	90	210	--	--
14	7-18-90	18.4	2,170	6.9	14.5	--	--	--	<1.0	2.4
	2-28-91		2,710	7.1	14.0	<5	260	30	--	--
15	7-19-90	220	1,080	7.1	15.5	--	--	--	4.8	7.7
	3-04-91		1,040	--	15.0	<5	1,300	50	--	--
16	7-17-90	22.0	466	6.0	17.0	--	--	--	3.9	10
	3-04-91		405	5.4	8.0	<5	140	190	--	--
17	7-17-90	200	721	7.5	21.0	--	--	--	2.7	3.5
	3-04-91		587	7.3	7.5	<5	<50	<20	--	--
18	7-17-90	16.8	467	7.1	17.0	--	--	--	<1.0	<1.0
	3-04-91		380	--	10.0	<5	280	20	--	--
19	7-17-90	8.0	512	7.6	22.0	--	--	--	2.7	7.2
	2-27-91		497	--	--	<5	250	170	--	--
20	7-17-90	--	523	7.3	26.0	--	--	--	1.2	5.4
	2-27-91		1,100	--	12.0	<5	110	40	--	--
21	7-17-90	24.5	349	7.6	23.0	--	--	--	<1.0	4.8
	3-05-91		472	--	15.0	<5	1,500	<20	--	--
22	7-19-90	51.5	524	7.3	20.5	--	--	--	1.5	6.5
	2-26-91		555	--	10.0	<5	80	<20	--	--
23	7-20-90	--	1,350	--	15.0	--	--	--	7.7	11
	3-06-91		1,340	--	--	<5	8,600	450	--	--
24	7-18-90	46.4	380	--	--	--	--	--	1.9	15
	2-26-91		713	--	11.0	<5	<50	<20	--	--
25	7-19-90	22.8	720	7.2	17.0	--	--	--	<1.0	12
26	7-19-90	18.8	1,270	6.9	16.5	--	--	--	6.4	12
	3-05-91		1,270	--	10.0	<5	480	50	--	--

Table 6--Physical properties and selected trace element and radionuclide concentrations of water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
				Bates County--Wells (Continued)						
27	7-18-90	18.4	870	7.0	18.5	--	--	--	2.4	3.7
	3-05-91		883	--	13.0	7	840	70	--	--
28	7-19-90	120	785	7.4	16.0	--	--	--	9.2	7.7
	3-05-91		819	--	15.0	<5	590	40	--	--
29	7-19-90	100	627	7.5	17.0	--	--	--	3.1	7.1
	3-05-91		2,280	--	10.0	<5	670	20	--	--
30	7-18-90	180	3,120	--	--	--	--	--	1.7	3.4
	3-06-91		2,870	--	--	<5	700	<20	--	--
31	7-19-90	100	2,440	7.1	18.5	--	--	--	<1.0	6.8
	3-04-91		2,730	7.2	13.0	<5	120	20	--	--
32	7-19-90	47.0	627	6.8	18.0	--	--	--	<1.0	3.0
	3-06-91		698	--	--	<5	90	20	--	--
33	7-18-90	27.2	522	--	--	--	--	--	1.7	9.7
	2-27-91		658	--	9.0	<5	<50	<20	--	--
34	7-18-90	54.0	1,140	--	--	--	--	--	<1.0	2.0
	3-04-91		1,110	--	11.0	<5	920	30	--	--
35	7-18-90	14.1	1,360	--	--	--	--	--	7.1	7.3
36	7-18-90	42.0	530	--	--	--	--	--	2.2	3.9
	3-04-91		708	--	17.0	<5	720	400	--	--
37	7-19-90	30.0	705	6.9	17.0	--	--	--	<1.0	<1.0
	3-04-91		747	--	11.5	<5	60	<20	--	--
38	7-19-90	22.5	344	--	--	--	--	--	<1.0	4.6
	2-27-91		315	--	10.0	<5	180	20	--	--

Table 6–Physical properties and selected trace element and radionuclide concentrations of water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
					Bates County--Spring					
1	7-17-90	--	420	6.4	--	--	--	--	1.3	2.7
	3-04-91		376	--	9.0	6	320	80	--	--
					Bates County--Surface-water sites					
1	7-16-90	--	495	7.7	27.0	--	--	--	--	--
2	7-16-90	--	1,380	8.0	29.0	--	--	--	--	--
3	7-19-90	--	1,730	8.2	26.0	--	--	--	--	--
4	7-16-90	--	445	7.6	26.0	--	--	--	--	--
					Cass County--Wells					
39	7-19-90	35.6	528	--	--	--	--	--	<1.0	1.5
	3-04-91		608	--	13.5	<5	<50	20	--	--
40	7-19-90	80.0	612	--	--	--	--	--	1.2	<1.0
	3-04-91		562	--	--	<5	160	20	--	--
41	7-19-90	25.0	2,060	7.2	19.0	--	--	--	1.5	7.3
	3-05-91		2,170	7.0	13.5	<5	470	30	--	--
42	7-19-90	22.0	705	7.2	20.0	--	--	--	<1.0	2.7
	3-05-91		784	--	9.0	<5	50	30	--	--
43	7-19-90	38.0	643	7.3	15.0	--	--	--	1.5	2.5
	2-28-91		872	--	13.0	<5	1,600	20	--	--
[b]44	7-19-90	80.0	794	--	--	--	--	--	16	8.6
	3-04-91		856	--	--	<5	120	20	--	--
45	7-19-90	50.0	381	6.7	14.0	--	--	--	1.3	4.7
	2-28-91		360	--	10.5	<5	80	20	--	--
46	7-19-90	15.0	931	7.3	22.0	--	--	--	2.9	6.3
	3-04-91		1,140	--	8.0	<5	120	<20	--	--
47	7-19-90	21.0	370	7.8	18.0	--	--	--	<1.0	1.6
	2-28-91		387	--	12.5	<5	240	30	--	--

Table 6–Physical properties and selected trace element and radionuclide concentrations of water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
				Cass County--Wells (Continued)						
48	7-19-90	21.0	872	7.5	20.0	--	--	--	2.5	4.7
49	7-19-90	25.0	626	7.4	21.0	--	--	--	1.6	5.4
	3-04-91		686	--	10.0	<5	50	<20	--	--
50	7-19-90	33.0	864	--	--	--	--	--	1.2	1.3
	3-04-91		886	--	14.0	<5	<50	380	--	--
51	7-19-90	36.0	452	--	--	--	--	--	1.1	7.7
	3-05-91		862	7.2	12.0	<5	60	<20	--	--
52	7-19-90	90.0	2,400	--	--	--	--	--	<1.0	5.7
	3-04-91		2,400	--	9.0	<5	500	<20	--	--
53	7-19-90	13.9	221	7.7	19.0	--	--	--	<1.0	2.2
	2-28-91		400	--	12.5	<5	80	20	--	--
54	7-19-90	120	2,680	--	--	--	--	--	<1.0	6.1
	3-05-91		3,640	--	--	<5	90	<20	--	--
55	7-19-90	30.0	902	--	--	--	--	--	4.1	2.3
	3-04-91		925	--	13.5	<5	220	20	--	--
56	7-20-90	35.7	780	--	--	--	--	--	4.9	2.2
	3-05-91		802	--	9.0	<5	130	20	--	--
57	7-19-90	45.0	2,500	--	--	--	--	--	1.7	3.3
	3-05-91		3,010	6.8	12.5	<5	380	70	--	--
58	7-20-90	28.6	1,260	6.9	15.0	--	--	--	<1.0	2.3
	3-07-91		1,300	6.9	12.0	<5	<100	<20	--	--
59	7-19-90	19.8	--	--	--	--	--	--	<1.0	20
	3-07-91		427	7.2	7.0	<5	1,000	<20	--	--
60	7-20-90	31.2	854	--	--	--	--	--	<1.0	1.8
	3-07-91		1,160	7.7	12.0	--	--	--	--	--
61	7-20-90	125	750	7.6	22.5	--	--	--	2.9	6.2
	2-28-91		800	--	6.0	<5	1,900	120	--	--

Table 6--Physical properties of selected trace elements and radionuclide concentrations of water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
				Cass County--Wells (Continued)						
62	7-20-90	37.6	1,020	7.2	15.0	--	--	--	1.7	4.0
	3-07-91		1,010	7.0	11.0	<5	<100	<20	--	--
63	7-19-90	24.0	1,170	--	--	--	--	--	<1.0	2.5
	3-05-91		1,090	6.9	9.5	<5	200	<20	--	--
				Cass County--Surface-water site						
5	7-19-90	--	484	8.4	31.0	--	--	--	--	--
				St. Clair County--Wells						
64	7-16-90	250	810	7.0	15.0	--	--	--	1.0	1.8
65	7-16-90	10.8	105	6.0	18.0	--	--	--	<1.0	1.1
66	7-16-90	60.0	145	6.0	15.0	--	--	--	<1.0	2.6
67	7-16-90	50.0	412	6.7	16.0	--	--	--	<1.0	1.1
68	7-16-90	69.5	252	5.9	15.0	--	--	--	<1.0	1.9
69	7-16-90	16.4	198	5.9	16.0	--	--	--	2.5	10
70	7-16-90	165	600	6.4	16.0	--	--	--	5.2	6.0
71	7-16-90	150	1,990	6.6	16.5	--	--	--	3.3	9.1
[c]72	7-17-90	128	238	6.4	16.0	--	--	--	1.3	1.3
73	7-17-90	225	1,290	7.1	16.0	--	--	--	8.7	12
74	7-17-90	170	984	7.1	16.0	--	--	--	6.6	14
[d]75	7-17-90	240	664	7.3	16.0	--	--	--	33	20
	11-06-90		--	--	--	--	--	--	38	24
76	7-17-90	260	764	7.3	16.0	--	--	--	4.3	9.2
77	7-17-90	310	874	7.1	16.0	--	--	--	20	19
	11-06-90		--	--	--	--	--	--	32	26
78	7-19-90	180	3,190	7.7	16.0	--	--	--	<1.0	16

Table 6–Physical properties of selected trace elements and radionuclide concentrations of water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
					Vernon County--Wells					
79	7-17-90	33.0	622	--	--	--	--	--	2.5	5.6
	2-26-91		822	--	--	<5	290	2,700	--	--
80	7-16-90	22.0	758	--	--	--	--	--	<1.0	7.0
	2-26-91		212	--	12.0	<5	1,700	60	--	--
81	7-16-90	24.9	210	--	--	--	--	--	3.1	11
	2-26-91		700	--	13.0	<5	570	4,900	--	--
			--	--	--	<5	540	4,800	--	--
82	7-16-90	26.4	132	--	--	--	--	--	<1.0	4.8
	2-26-91		90	--	10.0	<5	140	<20	--	--
83	7-16-90	31.6	1,460	--	--	--	--	--	<1.0	2.7
	2-25-91		980	--	9.0	6	1,200	1,700	--	--
84	7-16-90	105	--	--	--	--	--	--	2.1	10
	2-26-91		2,480	--	--	<5	110	100	--	--
85	7-16-90	25.0	384	--	--	--	--	--	<1.0	7.5
	2-25-91		393	--	--	<5	200	<20	--	--
86	7-17-90	90.0	1,330	--	--	--	--	--	1.7	7.0
	2-27-91		1,310	--	12.0	<5	1,800	460	--	--
87	7-16-90	33.0	224	--	--	--	--	--	<1.0	2.3
	2-25-91		247	--	10.0	<5	1,800	20	--	--
88	7-17-90	29.6	96	--	--	--	--	--	6.0	9.4
	2-25-91		88	--	10.0	<5	440	60	--	--
89	7-17-90	100	387	--	--	--	--	--	2.4	6.5
	2-28-91		731	--	12.0	<5	1,200	2,700	--	--
90	7-16-90	22.0	4,050	--	--	--	--	--	<1.0	5.3
	2-26-91		3,750	6.7	11.5	<5	130	130	--	--
91	7-18-90	21.1	1,360	6.6	17.0	--	--	--	1.7	3.5
	2-27-91		1,300	--	11.0	<5	<50	<20	--	--

Table 6--Physical properties of selected trace elements and radionuclide concentrations of water samples from wells, springs, and surface-water sites--Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
				Vernon County--Wells (Continued)						
92	7-18-90	60.0	310	7.0	16.0	--	--	--	<1.0	4.3
93	7-18-90	125	982	8.3	16.0	--	--	--	<1.0	4.5
94	7-16-90	27.0	434	--	--	--	--	--	3.5	15
	2-25-91		580	--	--	<5	<50	40	--	--
95	7-16-90	22.0	536	--	--	--	--	--	1.2	1.6
	2-25-91		556	--	--	<5	3,900	7,800	--	--
96	7-18-90	38.5	1,640	7.1	16.0	--	--	--	<1.0	1.1
	2-25-91		1,530	--	13.0	<5	80	120	--	--
97	7-16-90	65.0	2,240	7.3	25.0	--	--	--	1.4	5.9
	2-27-91		2,180	--	10.0	<5	3,200	610	--	--
98	7-16-90	--	476	7.4	20.0	--	--	--	<1.0	1.3
	2-25-91		459	--	10.0	<5	80	20	--	--
99	7-16-90	28.0	954	7.7	22.0	--	--	--	13	7.8
	2-27-91		956	--	--	<5	70	<20	--	--
100	7-17-90	34.0	95	6.9	24.0	--	--	--	<1.0	5.2
	2-28-91		1,070	--	12.0	<5	90	30	--	--
101	7-18-90	28.1	290	6.4	16.0	--	--	--	<1.0	6.2
	2-25-91		245	6.3	11.0	<5	200	<20	--	--
			--	--	--	<5	100	<20	--	--
102	7-16-90	18.0	470	4.7	17.0	--	--	--	3.2	6.0
	2-27-91		440	--	--	<5	370	450	--	--
103	7-18-90	21.4	2,490	7.4	16.0	--	--	--	<1.0	5.6
	2-25-91		2,050	--	9.5	<5	820	30	--	--
104	7-16-90	23.0	556	5.4	16.0	--	--	--	1.4	4.3
	2-26-91		1,020	--	15.0	<5	<50	760	--	--
105	7-16-90	26.0	312	7.2	16.0	--	--	--	<1.0	2.1
106	2-26-91	26.0	--	--	13.0	<5	2,200	350	--	--

Table 6–Physical properties of selected trace elements and radionuclide concentrations of water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
				Vernon County--Wells (Continued)						
107	7-16-90	40.9	1,460	6.3	--	--	--	--	11	10
	2-28-91		1,610	--	11.5	5	230	350	--	--
108	7-17-90	90.0	3,520	6.6	17.0	--	--	--	<1.0	5.4
	2-26-91		3,670	6.6	14.0	<5	2,700	1,200	--	--
109	7-16-90	15.0	945	7.6	22.0	--	--	--	6.2	6.4
	2-27-91		952	--	7.0	<5	100	<20	--	--
110	7-17-90	30.0	418	7.3	20.0	--	--	--	<1.0	2.8
	2-26-91		456	--	--	<5	60	<20	--	--
111	7-19-90	33.6	734	6.8	22.5	--	--	--	3.1	7.9
	2-25-91		705	6.6	11.0	5	120	90	--	--
112	7-18-90	20.0	782	6.7	19.0	--	--	--	1.2	4.5
	2-27-91		867	--	11.0	<5	180	20	--	--
113	7-16-90	20.0	238	7.8	22.0	--	--	--	<1.0	1.7
	2-25-91		750	7.2	9.5	<5	340	190	--	--
114	7-17-90	20.8	1,470	6.9	16.5	--	--	--	<1.0	3.0
	2-27-91		2,080	7.1	12.5	<5	60	<20	--	--
115	7-16-90	43.0	530	6.6	16.0	--	--	--	1.7	7.3
	2-26-91		694	6.3	12.0	<5	2,700	50	--	--
116	7-18-90	60.4	2,560	6.9	15.5	--	--	--	2.5	15
	2-26-91		2,560	--	12.0	<5	160	650	--	--
117	7-18-90	240	1,570	7.8	19.5	--	--	--	2.9	8.6
	2-26-91		1,510	--	12.5	<5	50	<20	--	--
118	7-18-90	55.0	1,750	6.3	17.0	--	--	--	<1.0	2.1
	2-26-91		1,630	--	13.0	<5	280	2,300	--	--
119	7-16-90	--	352	7.8	22.0	--	--	--	1.9	2.8
	2-25-91		1,960	6.9	12.0	<5	440	60	--	--

Table 6–Physical properties of selected trace elements and radionuclide concentrations of water samples from wells, springs, and surface-water sites–Continued

Site no. (fig. 1)	Date	Well depth (feet)	Specific conductance	pH (standard units)	Water temperature	Arsenic	Iron	Manganese	Alpha radiation	Beta radiation
				Vernon County--Wells (Continued)						
120	7-18-90	53.2	465	7.0	21.0	--	--	--	<1.0	10
	2-27-91		530	--	12.0	10	<50	<20	--	--
121	7-16-90	21.0	385	6.9	29.0	--	--	--	2.2	2.3
	2-27-91		614	--	10.0	<5	80	<20	--	--
				Vernon County--Springs						
2	7-17-90	--	353	--	--	--	--	--	1.2	6.9
	2-25-91		331	--	9.0	<5	160	<20	--	--
3	7-17-90	--	922	--	--	--	--	--	--	--
	2-25-91		442	--	9.0	<5	1,600	510	--	--
				Vernon County--Surface-water sites						
6	7-16-90	--	1,060	7.8	26.0	--	--	--	--	--
7	7-16-90	--	360	7.7	26.0	--	--	--	--	--

[a] Analyzed for radium-226 and concentration was 0.4 picocurie per liter; concentration of radium-228 was 0.8 picocurie per liter.
[b] Analyzed for radium-226 and concentration was 1.2 picocuries per liter; concentration of radium-228 was 0.4 picocurie per liter.
[c] Analyzed for radium-226 and concentration was 5.5 picocuries per liter; concentration of radium-228 was 0.6 picocurie per liter.
[d] Analyzed for radium-226 and concentration was 7.3 picocuries per liter; concentration of radium-228 was 0.9 picocurie per liter.