STATISTICAL SUMMARIES OF SELECTED CHEMICAL CONSTITUENTS IN KANSAS GROUND-WATER SUPPLIES, 1976-81

By Timothy B. Spruill

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CONVERSION FACTORS

For those readers interested in metric units, the inch-pound units used in this report can be converted to the International System of Units (SI) using the following factors:

Multiply inch-pound unit	By	To obtain SI unit
mile	1.609	kilometer
micromho per centimeter at 25°C (umhos/cm at 25°C	1.000	microsiemens percentimeter at 25°C

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ABSTRACT

Data on 24 chemical constituents or properties obtained from 766 wells in the Kansas Ground-Water-Quality Monitoring Network between 1976 and 1981 are statistically summarized in this report prepared in cooperation with the Kansas Department of Health and Environment. Minimum, median, and maximum concentrations and percentage of samples above "maximum contaminant levels" established by the U.S. Environmental Protection Agency are presented for all wells in the statewide network.

More detailed areal statistical summaries are presented for nine chemical constituents for which more than 3 percent of the observed concentrations exceeded the "maximum contaminant level" for that constituent. The State was divided into 14 ground-water regions based on water-use and physiographic characteristics. Summaries for these nine constituents include quartile values and percentage of samples with concentrations above the "maximum contaminant level" for each ground-water region. Accompanying maps show median concentrations and percentages of concentrations exceeding the "maximum contaminant levels" established by the U.S. Environmental Protection Agency for each ground-water region.

INTRODUCTION

The potentially detrimental effects of human activities on the quality of surface- and ground-water resources have caused increasing public concern and ultimately have led to enactment of the 1972 Federal Water Pollution Control Act Amendments (Public Law 92-500). The principal objective of this act was to "...restore and maintain the chemical, physical, and biological integrity of the Nation's water." In 1974, the Safe Drinking Water Act (Public Law 93-523) was passed to assure that public drinking-water supplies would meet minimum quality standards and that ground-water supplies would be protected from contamination from underground-waste injection procedures (Spruill and Kenny, 1981, p. 5).

In response to these two pieces of legislation, the Kansas Ground-Water-Quality Monitoring Network was established in 1976, as part of a cooperative program between the U.S. Geological Survey and the Kansas Department of Health and Environment (Spruill and Kenny, 1981, p. 5). Location of wells included in the network between 1976 and 1981 are shown in figure 1. Approximately 2,000 chemical analyses from 766 wells were obtained during this period.

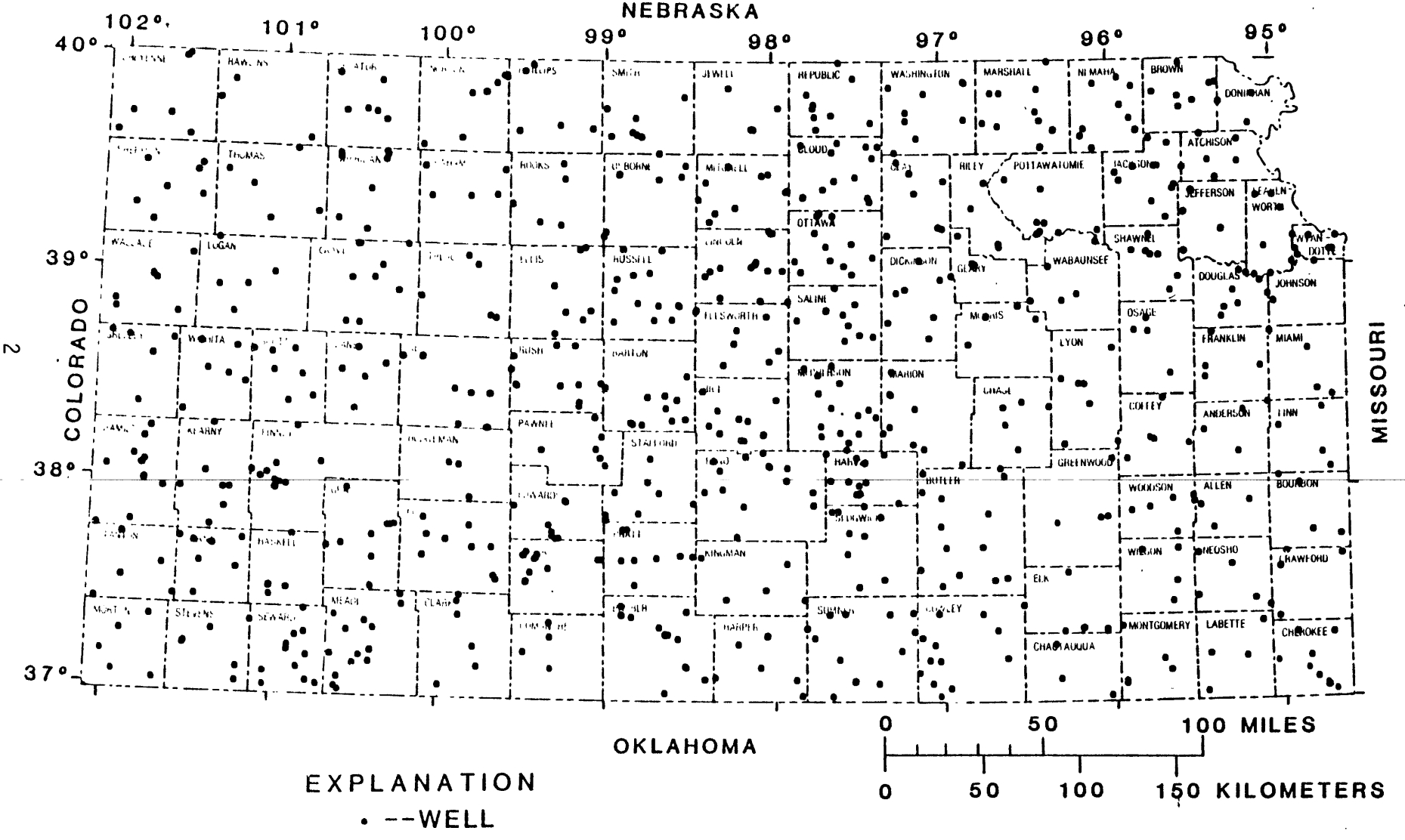

Figure 1.--Location of wells in Kansas Ground-Water-Quality Monitoring Network, 1976-81.

One major objective of the network was to evaluate the obtained data with respect to drinking-water standards imposed by the Safe Drinking Water Act. The purpose of this report is to summarize all data from the network and to provide statistical summaries on selected chemical constituents and properties for which more than 3 percent of the samples obtained exceeded the suggested or mandatory "maximum contaminant levels" established by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency, 1976; 1977). This information should be useful for the evaluation of regional ground-water supplies throughout Kansas.

METHODS

Selection of Wells and Sample Frequency

Between 1976 and 1981, 766 wells were sampled. Less than 40 wells were sampled during the first year of the network. For 1977-81, between 250 to more than 500 wells were sampled each year. Domestic, public, stock or irrigation wells were selected from well information available for each of 105 Kansas counties in the U.S. Geological Survey's WATSTORE header file. From four to six wells per county were sampled each year. Wells that had previous water-quality information were selected for inclusion in the network.

Wells selected for sampling were to be sampled once annually. Some wells, however, were discontinued during the period for various reasons (for example, the well may have been abandoned or destroyed). Most wells have from two to four analyses available for 1976-81.

Sample Collection and Laboratory Analysis

Samples were collected from wells as described by Wood (1976). Analyses for chemical constituents, trace elements, pesticides, and radiochemicals were made by the Division of Laboratories, Kansas Department of Health and Environment, according to methods described by the American Public Health Association (1975). Chemical constituents and physical properties that were determined are included in table 1. The detection limit for each chemical constituent or physical property is also given. Values below the detection limit are reported as zero.

Table 1.--Schedule of Analysis

[Values below the detection limit for each chemical or physical property or constituent are reported as zero]

Chemical constituent or physical property	Reporting units	Detection limit
Specific conductance	(micromhos)[1]	1
pH	(units)	0.1
Temperature	(degrees Celsius)	.1
Turbidity	(Nephlometric turbidity units)	.05
Hardness as $CaCO_3$	(mg/L)[2]	1
Noncarbonate hardness as $CaCO_3$	(mg/L)	1
Calcium, dissolved	(mg/L)	.1
Magnesium, dissolved	(mg/L)	.1
Sodium, dissolved	(mg/L)	1
Sodium, percent		
Sodium-adsorption-ratio		
Potassium, dissolved	(mg/L)	.1
Bicarbonate	(mg/L)	1
Carbonate	(mg/L)	1
Alkalinity	(mg/L)	1
Carbon dioxide, dissolved	(mg/L)	1
Sulfate, dissolved	(mg/L)	.1
Chloride, dissolved	(mg/L)	.1
Fluoride, dissolved	(mg/L)	.1
Silica, dissolved	(mg/L)	.1
Solids, residue at 180° C, dissolved	(mg/L)	1
Solids, sum of constituents,		
Nitrogen, nitrate dissolved as nitrogen	(mg/L)	.01
Phosphorus	(mg/L)	.01
Arsenic, dissolved	(µg/L)[3]	10
Barium, dissolved	(µg/L)	100
Cadmium, dissolved	(µg/L)	1
Chromium, dissolved	(µg/L)	10
Copper, dissolved	(µg/L)	10
Iron, dissolved	(µg/L)	10
Lead, dissolved	(µg/L)	10
Manganese, dissolved	(µg/L)	10
Mercury, dissolved	(µg/L)	1
Selenium, dissolved	(µg/L)	1
Silver, dissolved	(µg/L)	10
Zinc, dissolved	(µg/L)	10
Carbon, organic total	(mg/L)	.1
Endrin, total	(µg/L)	.1
Lindane, total	(µg/L)	.03

Table 1.--Schedule of Analysis--Continued

Chemical constituent or physical property	Reporting units	Detection limit
Methoxycholor, total	(µg/L)	.2
dissolved	(mg/L)	1
PCB, total	(µg/L)	.5
Toxaphene, total	(µg/L)	2
Dacthal, total	(µg/L)	.05
2, 4-D, total	(µg/L)	.4
Silvex, total	(µg/L)	.2
2, 4, 5-T, total	(µg/L)	.2
Gross alpha, suspended total	(pCi/L)[4] as uranium, natural	.1
Radium-226, dissolved	(PCi/L)	.1

[1] Micromhos per centimeter at 25°C.
[2] Milligrams per liter.
[3] Micrograms per liter.
[4] Picocuries per liter.

DRINKING-WATER REGULATIONS AND QUALITY OF KANSAS GROUND-WATER SUPPLIES

The Safe Drinking Water Act (Pl-92-523) was passed with the intent to provide safe drinking-water supplies to the public. As a result of this legislation, primary and secondary drinking-water regulations were promulgated in 1976 and 1977 and are based on criteria established by the U.S. Environmental Protection Agency. Primary regulations pertain to chemical constituents determined to affect the health of consumers and apply to finished (or treated) water supplies. All public-water supplies must be in compliance with these standards. Secondary regulations pertain to chemical constituents that affect the desirability or aesthetic properties of the water for consumptive use. Although secondary regulations are not enforceable, concentrations above "maximum contaminant levels" specified by the U.S. Environmental Protection Agency may render the water highly undesirable or totally unusable without treatment.

Statewide statistical summaries for 24 selected chemical constituents and properties for which primary or secondary regulations have been established are shown in table 2. The first and second columns show the constituent and unit of measurement. The third column shows the "maximum contaminant level" for the constituent or property, which is established by the U.S. Environmental Protection Agency. The fourth through seventh columns give the number of wells sampled and the minimum, median, and maximum concentrations. The eighth column gives the percentage of wells that produced water which exceeded the established "maximum contaminant level."

Table 2.--Statistical summaries of selected chemical constituents and properties of water from wells in the Kansas Ground-Water Quality-Monitoring Network, 1976-81, and "maximum contaminant levels"

[Values are given in milligrams per liter (mg/L), micrograms per liter (µg/L), and picocuries per liter (pCi/L)]

Chemical constituent or property (1)	Unit of measurement (2)	Maximum contaminant level ("MCL") (3)	Number of wells sampled (4)	Minimum concentration 1/ (5)	Median concentration (6)	Maximum concentration (7)	Percent of samples exceeding "MCL" (8)
Arsenic[2]	µg/L	50	623	0	1	50	<1
Barium[2]	µg/L	1,000	623	0	100	2,100	<1
Cadmium[2]	µg/L	10	581	0	0	100	<1
Chromium[2]	µg/L	50	631	0	0	30	0
Lead[2]	µg/L	50	586	0	0	200	<2
Mercury[2]	µg/L	2	569	0	.1	6	1
Nitrate-nitrogen[2]	mg/L	10	758	0	3.5	120	14
Selenium[2]	µg/L	10	641	0	2	134	13
Fluoride[2,3]	mg/L	1.4-2.4	761	.1	.4	6.8	3-10
Endrin[2]	µg/L	.2	165	0	0	0	0
Lindane[2]	µg/L	4	165	0	0	0	0
Methoxychlor[2]	µg/L	100	165	0	0	0	0
Toxaphene[2]	µg/L	5	165	0	0	0	0
2,4-D[2]	µg/L	100	161	0	0	0	0
Silvex[2]	µg/L	10	161	0	0	.2	<1
Gross-alpha[2]	pCi/L	15	153	0	4.9	44	10
Chloride	mg/L	250	760	2	32.5	3,800	8
Copper	µg/L	1,000	631	0	0	1,700	<1
Iron	µg/L	350	613	0	20	15,000	11
Manganese	µg/L	50	612	0	10	3,300	20
pH[4]	units	5.5<pH<8.5	763	5.6	7.3	9.0	1
Sulfate	mg/L	250	766	4	73	2,800	16
Zinc	µg/L	5,000	631	0	20	9,300	<1
Dissolved solids	mg/L	500	612	83	442	2,850	40

1 Zero values indicate concentrations less than the detection limit for each chemical constituent or physical property.
2 Constituents having primary drinking-water regulations.
3 The "maximum contaminant level" for fluoride ranges from 1.4 to 2.4 mg/L, depending upon the mean annual temperature of the region. In this analysis, 10 percent exceeded 1.4 mg/L, and 3 percent exceeded 2.4 mg/L.
4 Drinking water should not be less than 5.5 and greater than 8.5 pH units. No measurements were obtained that were less than the lower limit of 5.5.

GROUND-WATER REGIONS OF KANSAS

To allow water managers to assess possible regional water-quality problems within the State, Kansas was divided into 14 ground-water regions, which are relatively homogeneous with respect to topographical, geological, land-use, and water-use features and are similar to physiographic divisions of the State presented in Schoewe (1949). These ground-water regions are shown in figure 2.

The following narratives describe general characteristics of regional water supplies, geology, and principal aquifers within each region. Estimates of the relative importance of ground- and surface-water supply sources were based in part on information in "The Kansas State Water Plan Studies--Long-range water supply problems, phase I," (U.S. Bureau of Reclamation, 1974).

1.) Approximately one-half of all water supplied for region 1 is derived from ground-water reservoirs. The principal aquifers used for public supplies in the region are unconsolidated glacio-fluvial sand and gravel deposits of Pleistocene age. Unconsolidated alluvial deposits, particularly in large stream valleys, also are major sources for irrigation, public, and domestic stock supplies. Rural domestic and stock supplies are obtained from Permian-age limestones in the western part of region 1, and are derived from Pennsylvanian-age limestones, shales, and sandstones in the eastern part. A few public supplies are also derived from Pennsylvanian sandstones in the eastern part.

2.) Less than 20 percent of water supplied for region 2 is derived from ground-water reservoirs. Most of the ground-water is used primarily for domestic and stock supplies. The principal aquifers are composed of limestones, shales, and sandstones of Pennsylvanian age with the best aquifers composed of sandstones. Most public supplies are derived from surface-water sources. Most wells in this area are developed in the upper weathered portion of Pennsylvanian-age rocks, and well depths range from less than 20 feet to more than 250 feet, with most probably less than 80 feet in depth.

3.) Ground-water reservoirs provide almost all water for public, domestic, and stock uses in region 3. Most public and domestic supplies are derived from Cambrian- and Ordovician-age dolomites. Well depths are usually more than 500 feet in these deep aquifers. Small domestic and stock supplies are derived from rocks of Mississippian age in the southeastern part where well depths range from 150 to 400 feet; shallow wells of less than 30 feet in depth also supply water for small domestic and stock supplies from Pennsylvanian-age sandstones and shales in the western part.

4.) Ground-water reservoirs supply more than a one-third of water supplies in region 4 . Limestones of Permian age are used for domestic, stock, and public supplies throughout much of the region, with the principal uses being for domestic and stock supplies. Wells generally range from 50-200 feet in depth. Unconsolidated alluvial deposits in the larger river valleys supply water for irrigation, public, domestic, and stock supplies. Wells in these alluvial deposits generally range between 20 and 100 feet in depth.

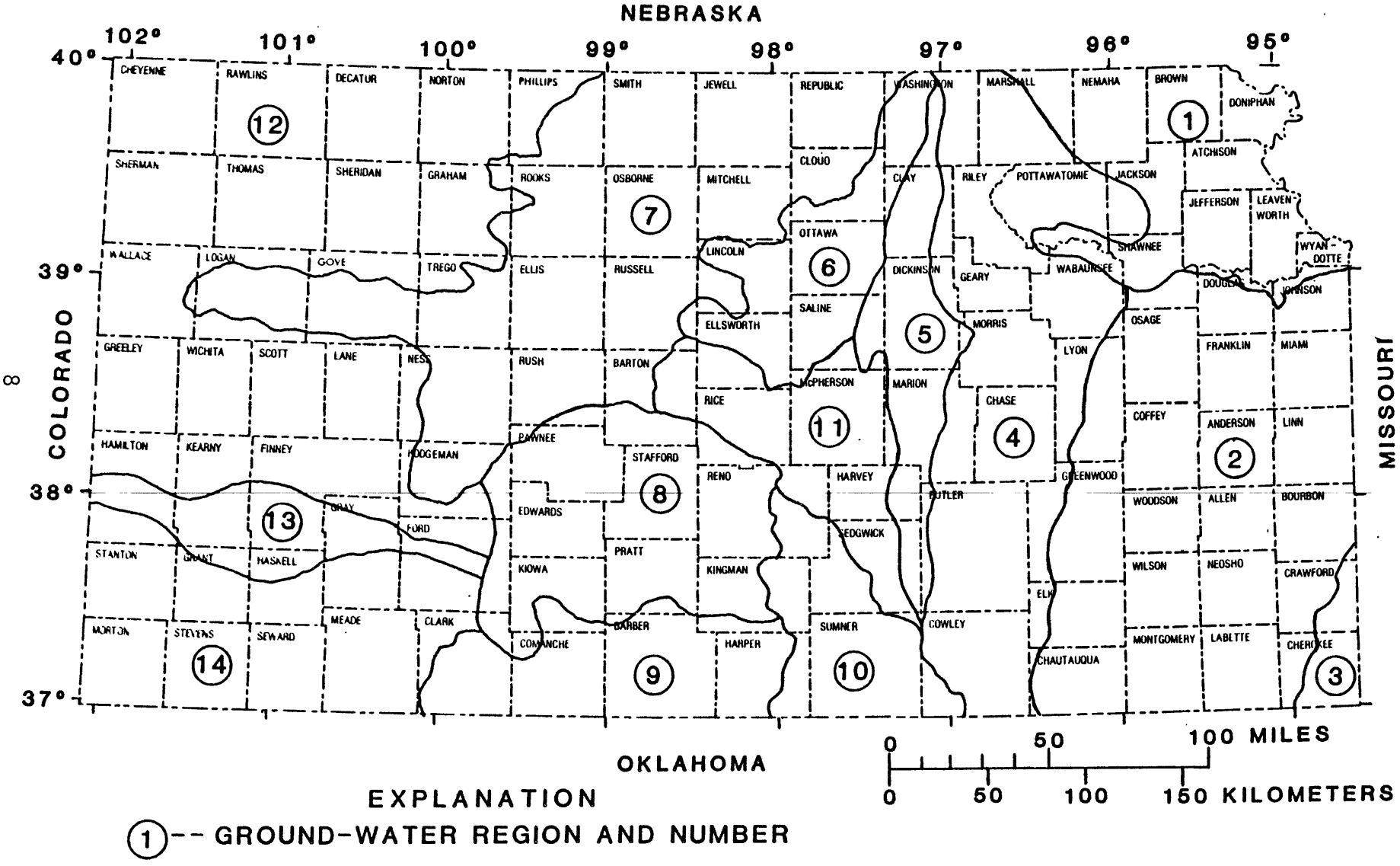

Figure 2.--Ground-water regions of Kansas.

5.) Permian-age shales and limestones containing beds of gypsum and anhydrite provide domestic, stock, and, in the central and southern part, some public supplies. Wells are typically less than 100 feet in depth. Generally, however, well yields are poor, and surface water provides most public supplies for region 5. Irrigation, public, domestic, and stock supplies are derived from alluvial deposits in the Kansas River valley in the north-central part of the region.

6.) Ground water is the source of more than one-half of all water used in region 6. Cretaceous sandstones provide public, domestic, and stock supplies throughout the region, with well depths ranging from 20 to over 200 feet in depth. Alluvial deposits in major river valleys are principal water-supply sources for these uses, as well as for irrigation supplies.

7.) Ground water is the major water-supply source in region 7 for public, domestic, and stock uses. Although surface water has been used in the past to supply water for irrigation, ground water is likely to be the major supply for this use in the future. The major source of ground-water supplies are unconsolidated alluvial deposits in the river valleys. Small domestic and stock supplies are also derived from Cretaceous-age shales, limestones and sandstones, with sandstones providing public supplies as well in the southern part.

8.) Ground water is the major water-supply source in region 8. Thick deposits of unconsolidated sand and gravels of Pleistocene and Miocene age comprise the major aquifer in this region, although shallow (less than 80-feet thick) alluvial deposits in the Arkansas, North and South Fork of the Ninnescah, Chikaskia, and the Pawnee River valleys are significant aquifers. Cretaceous-age rocks subcrop in the western part of region 8 and are also used for water supplies to a limited extent. Permian-age rocks subcrop in the eastern part but are not significant sources of usable water.

9.) More than 90 percent of water supplied for public, irrigation, domestic, and stock uses are obtained from ground-water reservoirs in region 9. Principal sources of ground water for most uses are Pleistocene-age alluvial sands and gravels in stream valleys. Domestic and stock supplies are also derived from Permian shales and sandstones in the region.

10.) Ground water is the primary source of water supply in region 10. Ground-water supplies for public, irrigation, domestic, and stock uses are derived from unconsolidated deposits of Pleistocene age, terrace and alluvial deposits. Most wells in these aquifers are less than 50 feet in depth. Permian-age limestones and shales provide small supplies for domestic, stock, and, in a few cases, public uses.

11.) Ground water is the major water-supply source in region 11. Unconsolidated outwash deposits of Pleistocene age, which range in thickness from less than 40 feet at the edges to over 300 feet in ancient buried channels, are the principal water-supply source. Alluvial deposits of the Arkansas and Little Arkansas Rivers, which are generally less than 100 feet in thickness, also provide a major source of ground water for the region. Permian-age rocks subcrop throughout most of this region.

12.) Ground-water reservoirs provide, almost exclusively, water for irrigation, public, domestic, and stock supplies in region 12. Unconsolidated Tertiary deposits of up to 450 feet in thickness are the source of most water in the region, with most wells being more than 150 feet deep. Pleistocene-age deposits also provide water for most uses, with well depths of less than 100 feet. A few domestic and stock supplies are derived from Cretaceous-age sandstones in the southwestern corner of this region. Cretaceous-age rocks subcrop throughout this area.

13.) Ground water from unconsolidated alluvium in the western part of region 13 and from alluvium and deep Miocene deposits in the eastern part are the main sources for public, domestic, irrigation, and stock uses. Cretaceous-age shales and sandstones provide some domestic and stock supplies in the western part. Cretaceous-age bedrock subcrops through most of the area.

14.) Ground water from unnconsolidated deposits of Miocene age provide most supplies for region 14, with unconsolidated Pleistocene-age alluvium providing some irrigation, domestic, and stock supplies. Some domestic and stock supplies are also obtained from Cretaceous-age sandstones in the western part. Permian-age rocks subcrop throughout most of this region.

STATISTICAL SUMMARIES OF SELECTED CHEMICAL CONSTITUENTS

The following statistical summaries are presented for dissolved-solids, chloride, fluoride, iron, nitrate-nitrogen, manganese, selenium, sulfate, and total gross-alpha concentrations in Kansas ground-water supplies. Concentrations for each of these constituents exceeded the "maximum contaminant levels" for more than 3 percent of the wells sampled (see table 1). Data for each chemical constituent were first summarized by computing median values for each well. One to six analyses were included for each well. Data for each chemical constituent then were summarized by area (ground-water regions 1-14 in figure 2).

Tables 3-11 show values for the first, second, third, and fourth quartiles and the percentage of wells sampled that exceeded the "maximum contaminant levels" for each ground-water region. The first quartile value represents the concentration where 25 percent of the observed concentrations were less than this value. The second quartile value (or median) is the value for which 50 percent of the concentrations were below the specified value. The third quartile value is the concentration for which 75 percent of the observed concentrations were less than this value. The fourth quartile value (or maximum) is the maximum observed concentration. Figures 3-11 show the approximate median concentrations and percentages exceeding the "maximum contaminant level" for each of the 14 ground-water regions.

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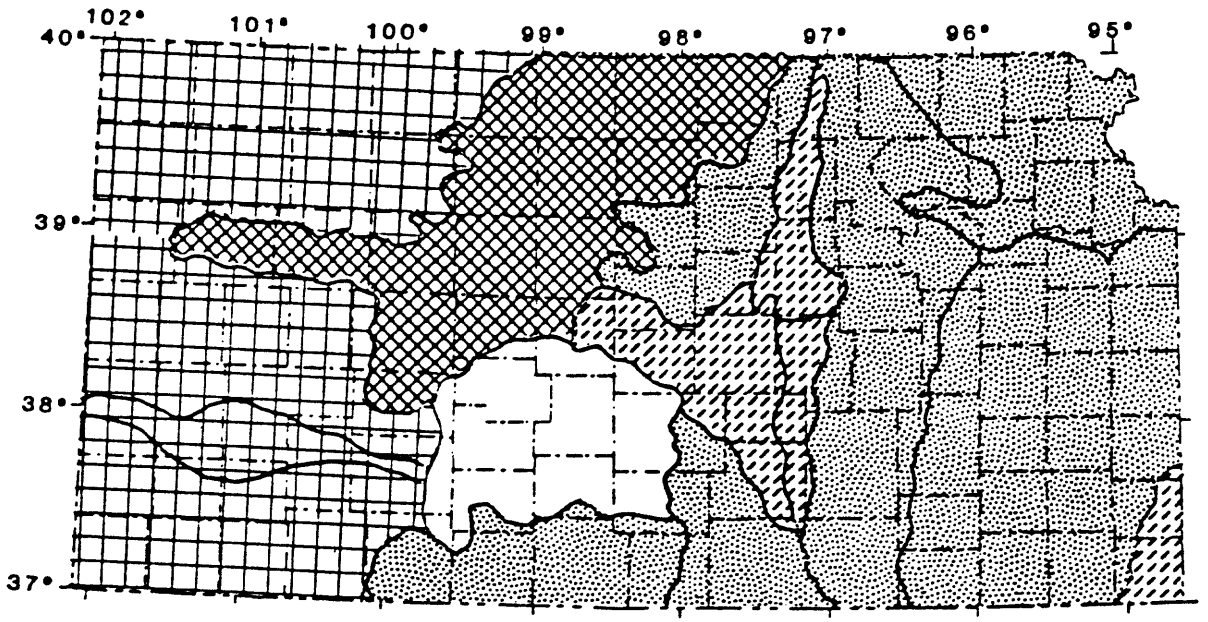
Table 3.--Dissolved-solids concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (milligrams per liter) 1st	2nd (median)	3rd	4th (maximum)	Percent above "MCL"[1/]
1	61	344	439	522	943	31
2	67	297	432	673	1,170	39
3	7	294	562	593	997	71
4	53	408	480	640	842	33
5	12	254	575	701	919	58
6	55	349	454	682	975	42
7	74	506	646	784	1,090	77
8	52	258	294	368	711	6
9	14	363	470	640	780	50
10	21	306	411	643	832	38
11	40	409	522	648	951	57
12	88	325	371	500	975	25
13	22	304	370	651	2,850	26
14	45	329	381	504	907	24

1 "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977).



A. MEDIAN CONCENTRATIONS

EXPLANATION

CONCENTRATION, IN MILLIGRAMS PER LITER

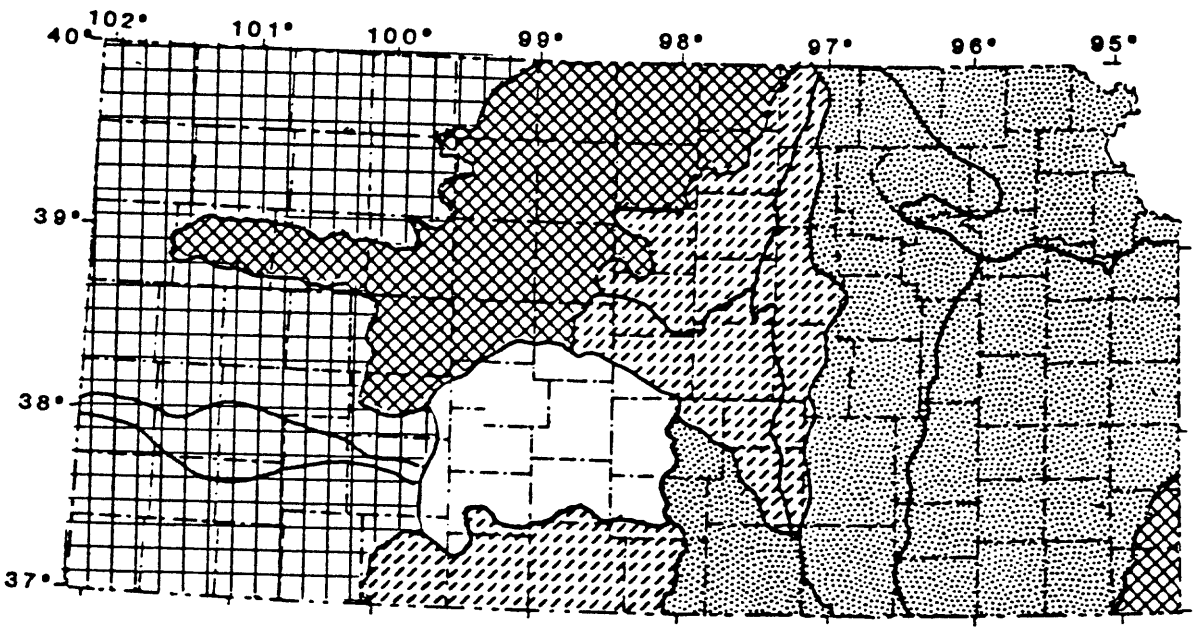
0–300

301–400

401–500

501–600

> 600



B. PERCENTAGE OF CONCENTRATIONS EXCEEDING "MAXIMUM CONTAMINANT LEVEL"

EXPLANATION

PERCENTAGE

0–10

11–30

31–40

41–60

> 60

0 50 100 MILES

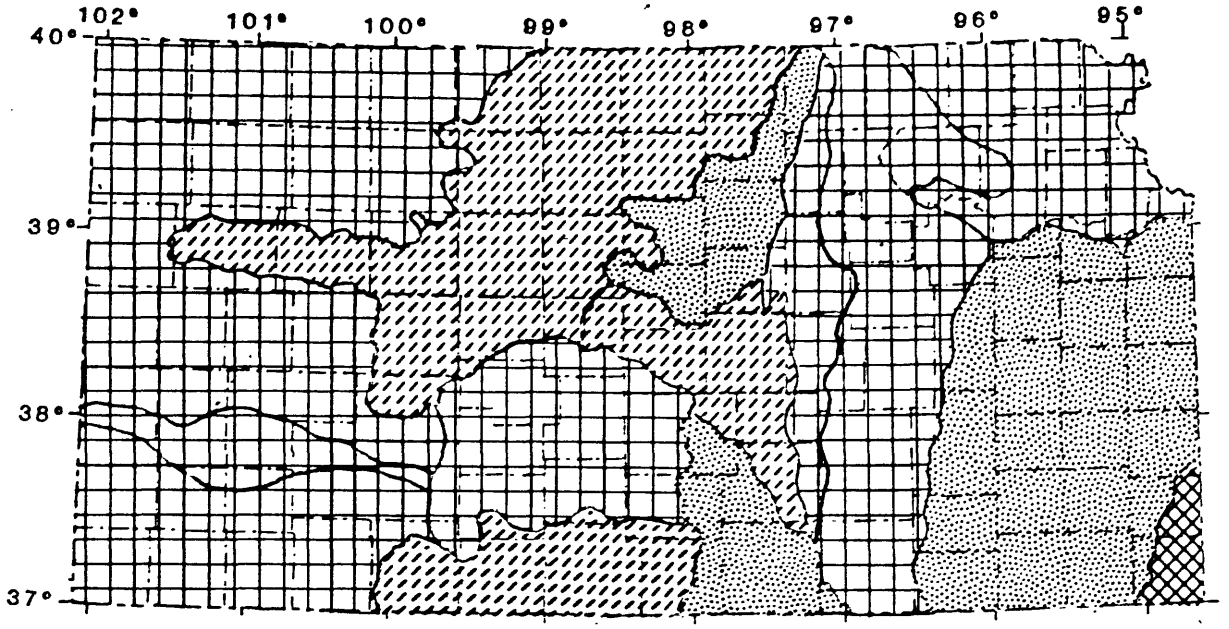
0 50 100 150 KILOMETERS

Figure 3.--Dissolved-solids concentrations in Kansas ground-water supplies.

Table 4.--Dissolved chloride concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (milligrams per liter) 1st	2nd (median)	3rd	4th (maximum)	Percent above "MCL"[1/]
1	71	9.5	19	59	910	6
2	83	16	33	82	2,215	10
3	9	36	170	392	640	40
4	60	15	27	58	300	2
5	18	19	29	73	360	6
6	62	17	33	92	430	6
7	111	39	65	150	3,800	12
8	62	12	20	44	2,000	3
9	25	29	88	207	3,225	16
10	24	16	41	238	1,100	25
11	50	26	80	140	690	16
12	96	14	23	44	140	0
13	29	11	24	106	370	7
14	59	15	19	32	350	3

1/ "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977).



A. MEDIAN CONCENTRATIONS

EXPLANATION

CONCENTRATION, IN MILLIGRAMS PER LITER

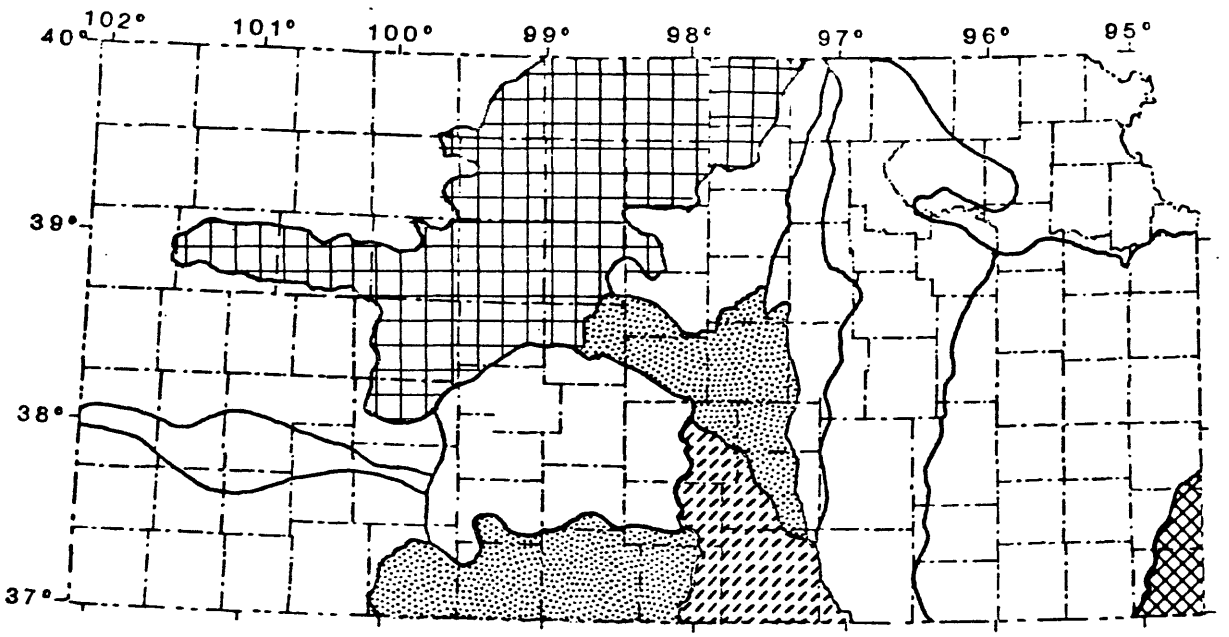
0-10

11-30

31-50

51-100

> 100



B. PERCENTAGE OF CONCENTRATIONS EXCEEDING "MAXIMUM CONTAMINANT LEVEL"

EXPLANATION

PERCENTAGE

0-10

11-15

16-20

21-30

> 30

0 50 100 MILES

0 50 100 150 KILOMETERS

Figure 4.--Dissolved chloride concentrations in Kansas ground-water supplies.

Table 5.--Dissolved fluoride concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (milligrams per liter) 1st	2nd (median)	3rd	4th (maximum)	Percent above "MCL"[1/]
1	71	0.2	0.3	0.40	1.1	0
2	82	.2	.3	.50	6.5	8
3	10	.3	.8	1.5	2.2	30
4	60	.2	.3	.4	1.4	<2
5	18	.3	.4	.7	1.2	0
6	62	.2	.3	.4	1.5	<2
7	111	.3	.4	.7	6.4	13
8	62	.2	.3	.4	1	0
9	25	.4	.5	.7	1.2	0
10	24	.1	.2	.3	6.8	4
11	53	.2	.3	.5	1	0
12	95	.6	1.1	1.7	3.5	35
13	29	.5	.9	1.2	1.8	13
14	59	.5	.8	1.1	3.6	14

1/ "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977). 2.4 mg/L is considered the "MCL" for all regions in this report, although the actual "MCL" depends on the regional mean annual temperature.

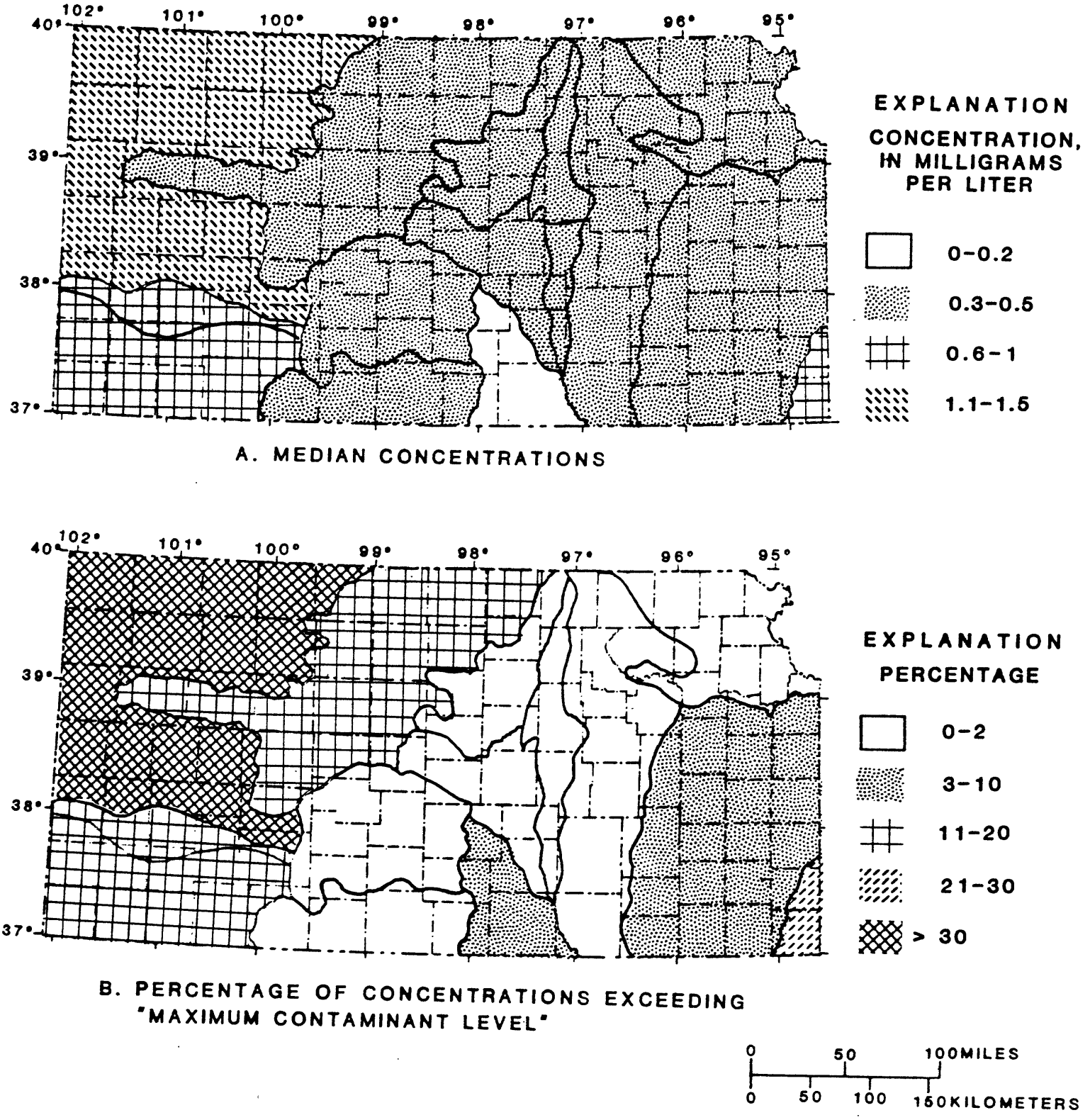


Figure 5.--Dissolved fluoride concentrations in Kansas ground-water supplies.

Table 6.--Dissolved iron concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (micrograms per liter) 1st	2nd (median)	3rd	4th (maximum)	Percent above "MCL"[1/]
1	62	10	30	510	15,000	26
2	73	10	20	50	5,900	5
3	9	35	80	1,200	1,700	44
4	54	10	15	40	3,600	11
5	17	10	10	30	1,300	18
6	40	20	40	468	9,600	25
7	85	20	30	160	8,400	19
8	47	10	10	20	500	4
9	18	10	12	65	550	6
10	14	10	20	30	40	0
11	40	10	20	48	3,000	10
12	81	10	10	20	2,900	4
13	17	10	10	20	180	0
14	54	10	10	11	120	0

1 "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977).

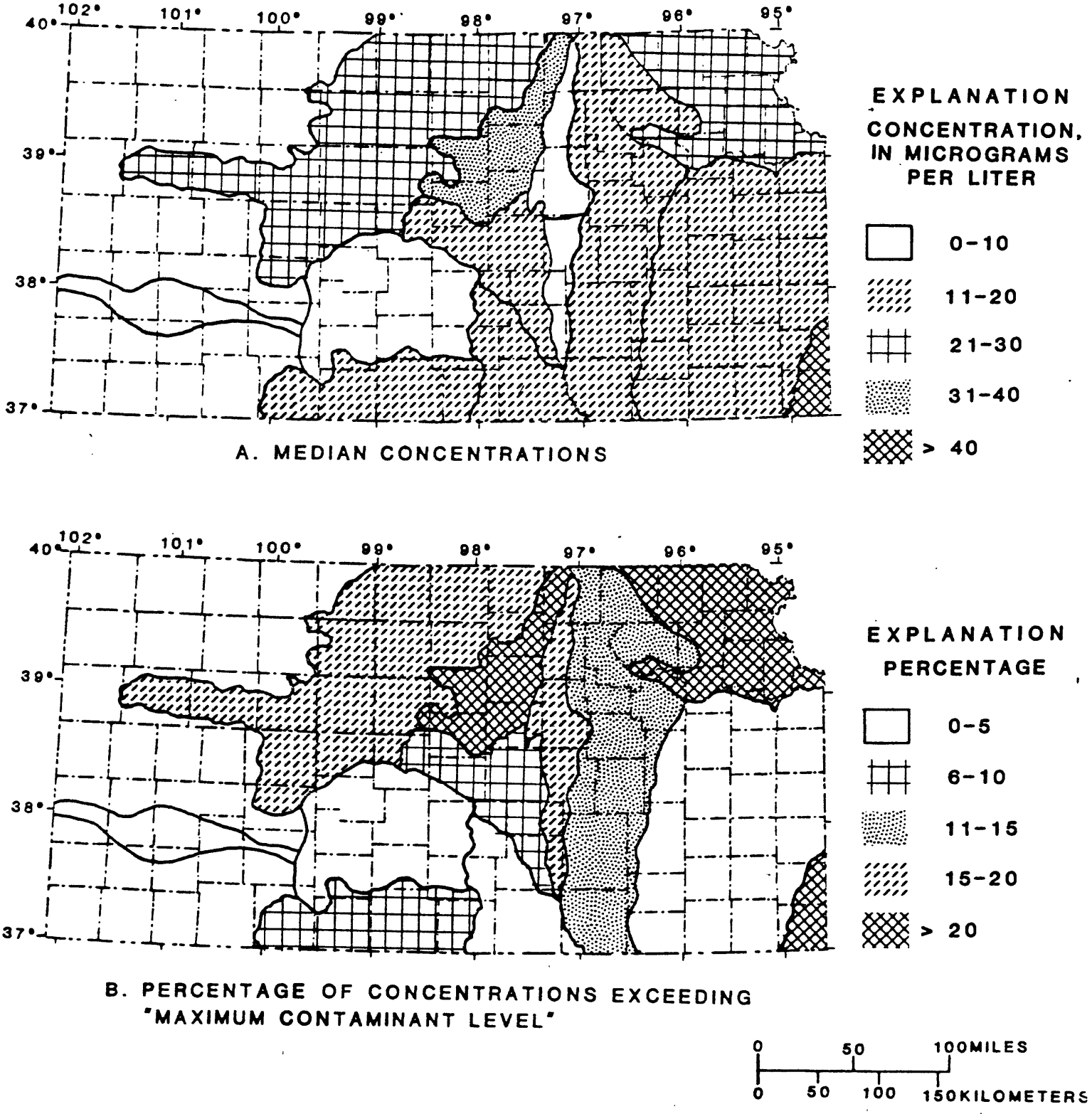


Figure 6.--Dissolved iron concentrations in Kansas ground-water supplies.

Table 7.--Dissolved nitrate-nitrogen as (N) concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (milligrams per liter) 1st	2nd (median)	3rd	4th (maximum)	Percent above "MCL"[1/]
1	71	0.1	1.5	7.0	89	13
2	82	.7	4.0	13	120	30
3	10	0	0	0	.6	0
4	60	1.2	3.9	7.8	15	11
5	18	.2	2.7	10	28	22
6	62	.3	2.8	6.1	87	14
7	112	.4	2.8	6.6	56	14
8	62	3.7	5.6	8.7	29	11
9	25	.6	2.7	8.0	41	20
10	24	.9	3.2	7.4	13	8
11	53	.6	3.4	5.8	26	10
12	95	3.1	4.5	6.0	32	6
13	28	.3	2.7	6.7	21	11
14	48	.1	3.2	3.9	13	2

[1] "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977).

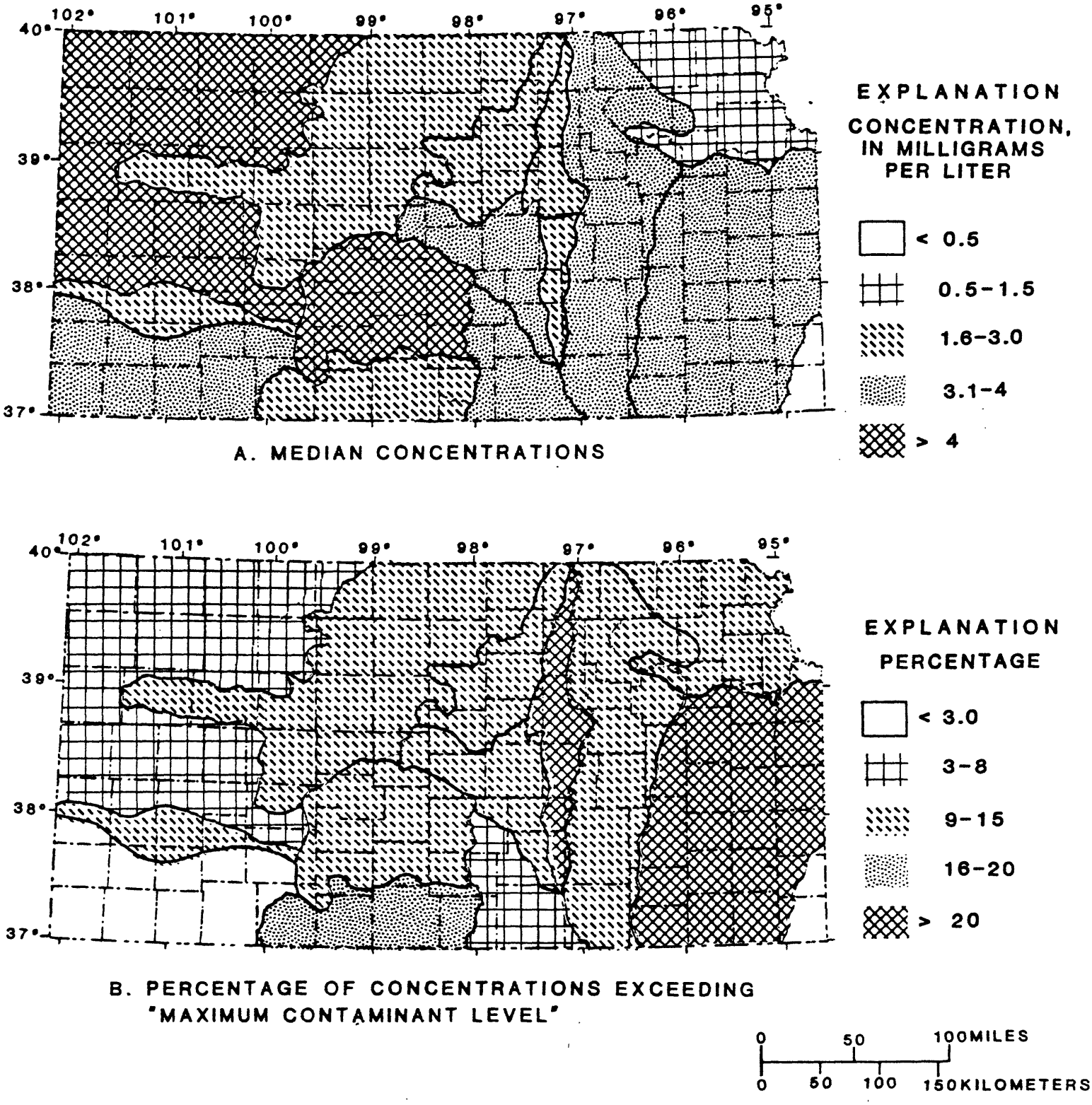


Figure 7.--Dissolved nitrate-nitrogen concentrations in Kansas ground-water supplies.

Table 8.--Dissolved manganese concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (micrograms per liter) 1st	2nd (median)	3rd	4th (maximum)	Percent above "MCL"[1/]
1	62	10	30	265	1,700	43
2	73	10	10	20	2,200	18
3	9	10	10	25	60	11
4	54	10	10	20	3,300	18
5	17	10	10	55	75	18
6	40	10	10	110	1,300	35
7	85	10	10	140	960	32
8	47	10	10	10	120	4
9	18	10	10	158	460	33
10	14	10	10	30	780	21
11	40	10	20	48	3,000	25
12	80	10	10	10	980	9
13	17	10	10	20	180	12
14	54	4.5	10	10	10	0

1 "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977).

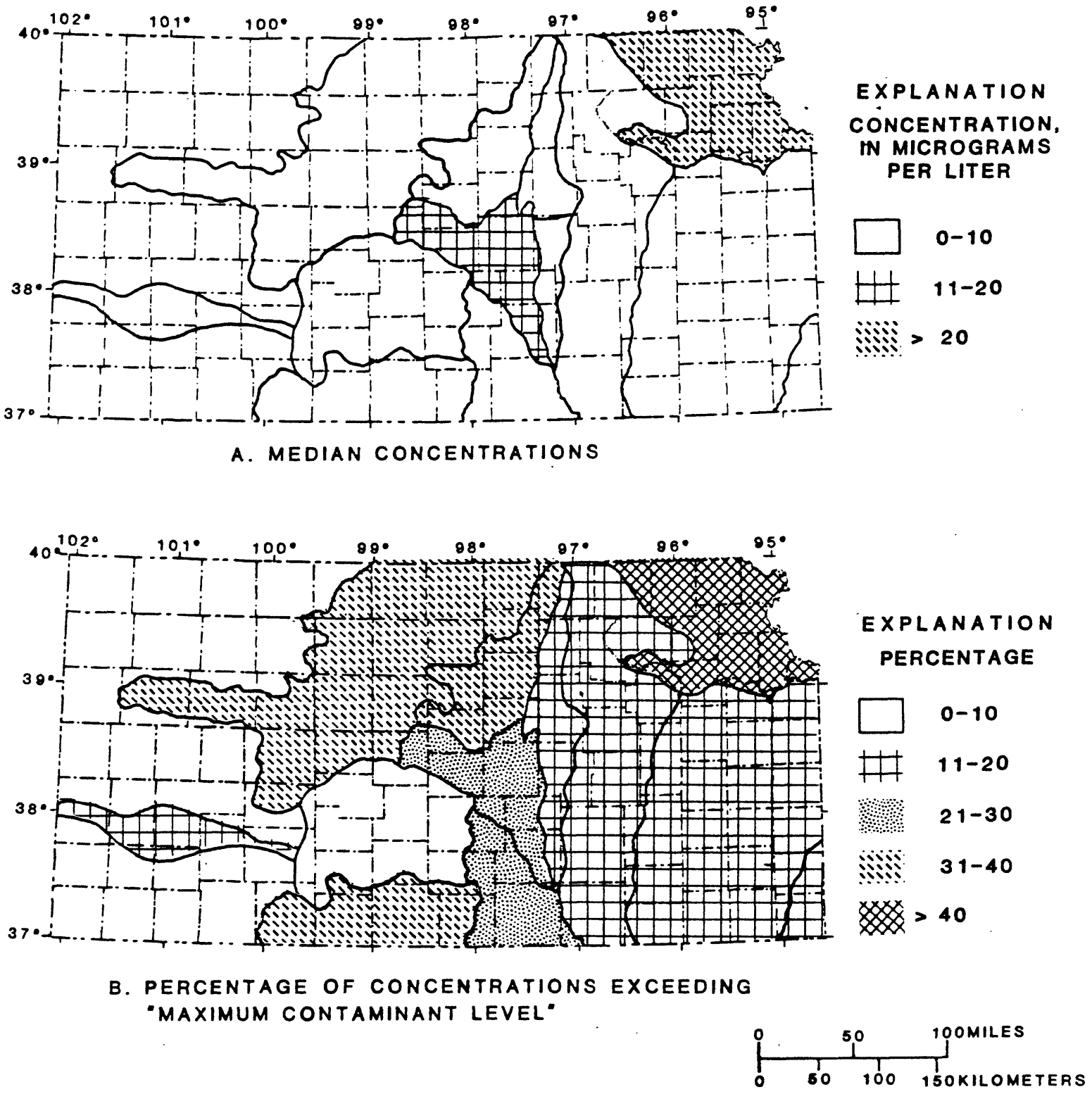


Figure 8.--Dissolved manganese concentrations in Kansas ground-water supplies.

Table 9.--Dissolved selenium concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (micrograms per liter) 1st	2nd (median)	3rd	4th (maximum)	Percent above "MCL"[1/]
1	61	0	1	1.5	46	4
2	74	0	1	2	134	4
3	9	0	1	1.5	3	0
4	58	1	1.5	4	16	2
5	17	2	3	19	100	30
6	49	1	2	4.5	50	14
7	91	1	5	13	84	32
8	62	1	1	2	11	4
9	19	1	2	5	25	5
10	22	1	1.5	4	17	9
11	44	1	1.5	3	22	13
12	101	2	4.5	7	39	20
13	17	3.5	10	21	29	52
14	54	3	4	7	31	16

1 "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977).

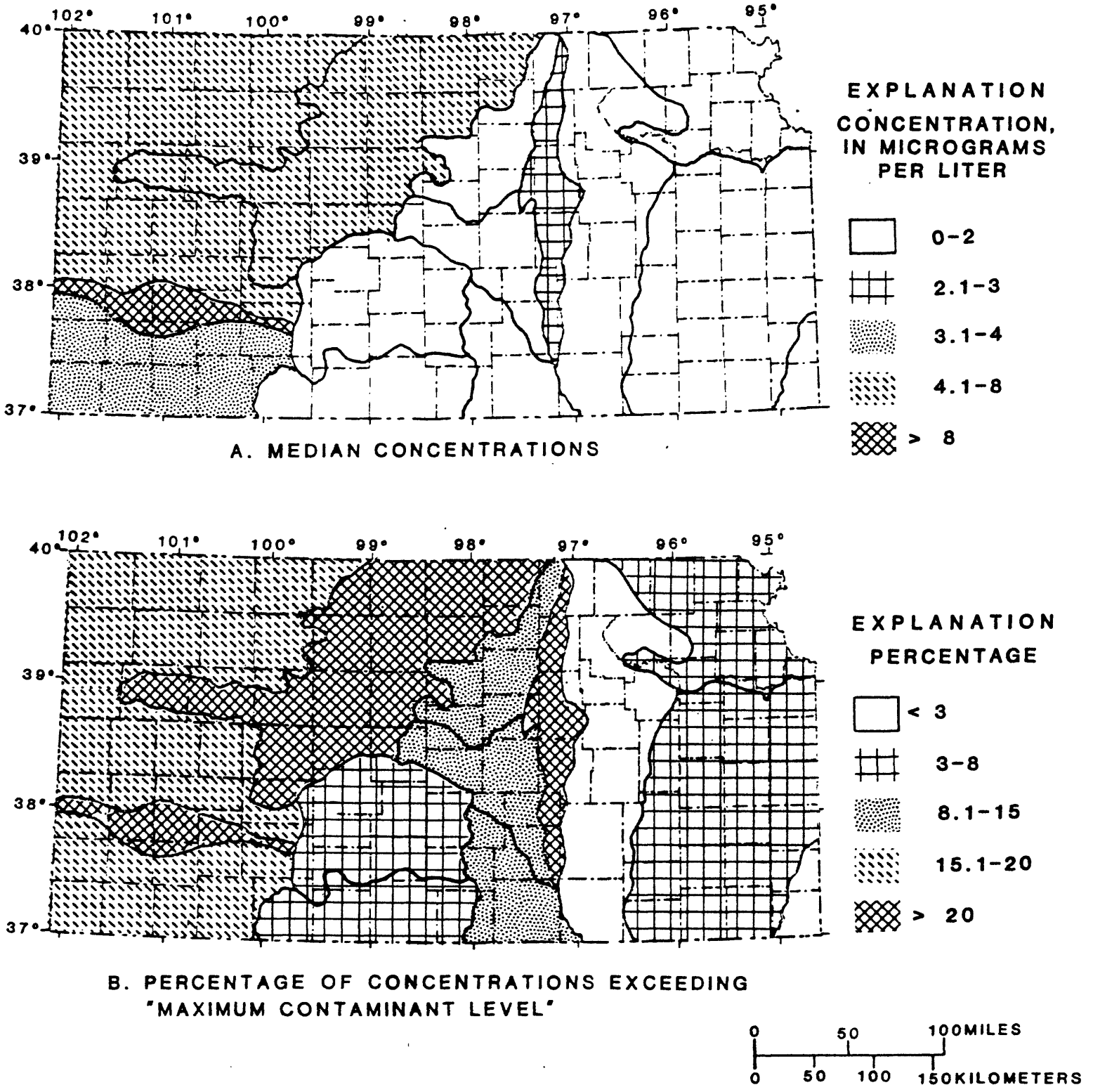


Figure 9.--Dissolved selenium concentrations in Kansas ground-water supplies.

Table 10.--Dissolved sulfate concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (milligrams per liter) 1st	2nd	3rd	4th	Percent above "MCL"[1/]
1	71	21	44	76	1,200	7
2	83	36	74	165	1,800	20
3	10	36	92	155	610	10
4	60	30	62	180	1,500	15
5	18	51	275	930	1,950	56
6	62	39	79	210	1,700	14
7	112	92	160	338	1,700	33
8	62	13	20	37	630	3
9	25	80	260	806	2,000	52
10	24	25	70	116	1,000	8
11	53	29	57	95	500	4
12	96	33	52	108	630	2
13	29	76	160	1,105	2,800	40
14	59	53	90	140	325	5

[1] "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977).

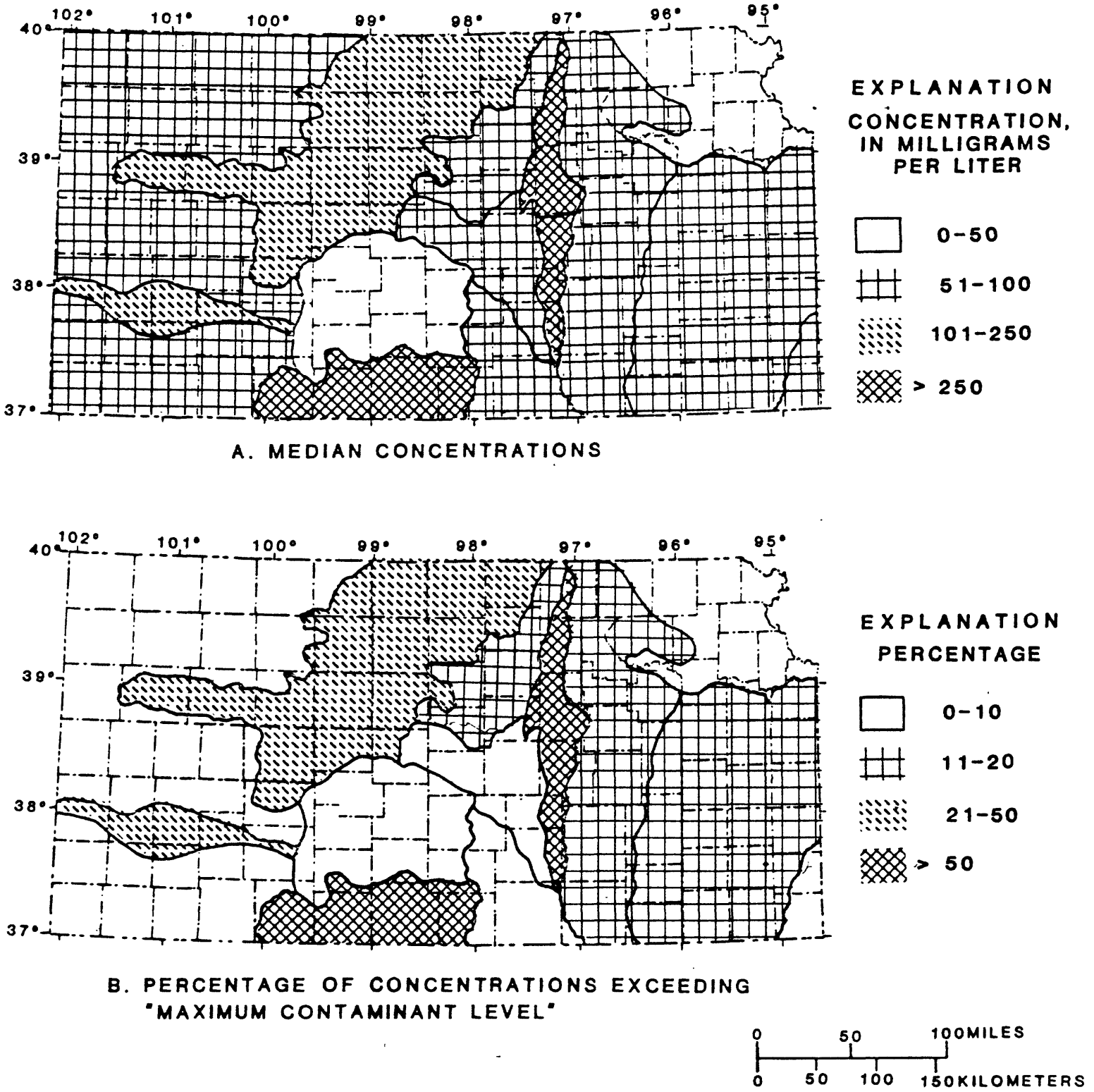
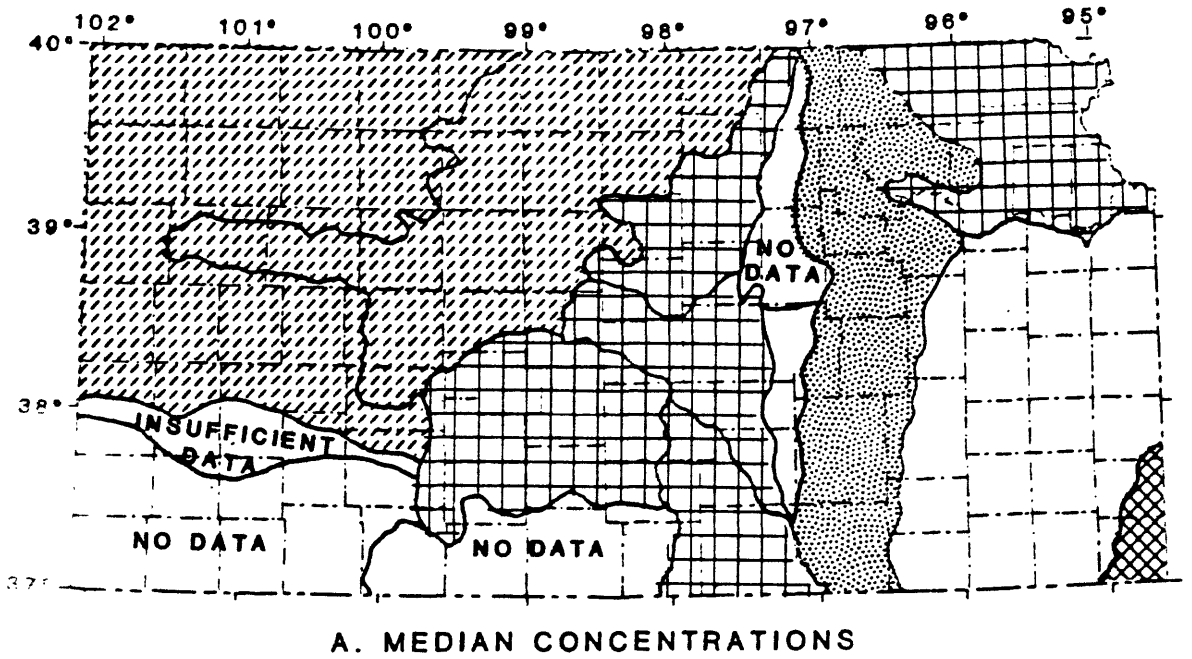


Figure 10.--Dissolved sulfate concentrations in Kansas ground-water supplies.

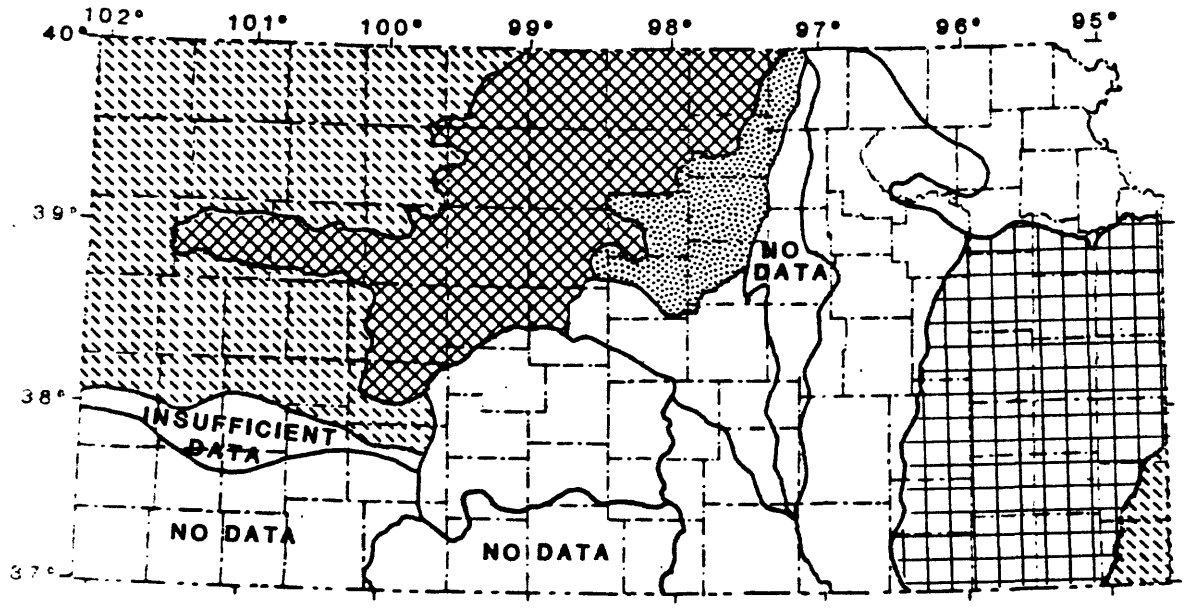
Table 11.--Total gross-alpha concentrations in Kansas ground-water supplies

Ground-water region	Number of samples	Quartile values (picocuries per liter) 1st	2nd (median)	3rd	4th (maximum)	Percent above "MCL"[1/]
1	17	2	3	4.5	11	0
2	16	2	2	3	44	6
3	8	7.2	9.5	11.2	27	12
4	7	4	6	8	12	0
5	no data	--	--	--	--	--
6	9	2.5	3	9	15	10
7	18	4	8	10.5	38	16
8	5	1.5	4	7.5	8	0
9	no data	--	--	--	--	--
10	5	.5	3	4	5	0
11	12	2	3.5	8.8	11	0
12	9	6.5	9	10	18	11
13	3	--	--	--	--	--
14	no data	--	--	--	--	--

1 "MCL" is the "maximum contaminant level" established by the U.S. Environmental Protection Agency (1976; 1977).



A. MEDIAN CONCENTRATIONS



B. PERCENTAGE OF CONCENTRATIONS EXCEEDING "MAXIMUM CONTAMINANT LEVEL"

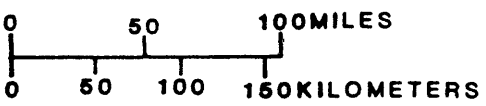


Figure 11.--Total gross-alpha concentrations in Kansas ground-water supplies.