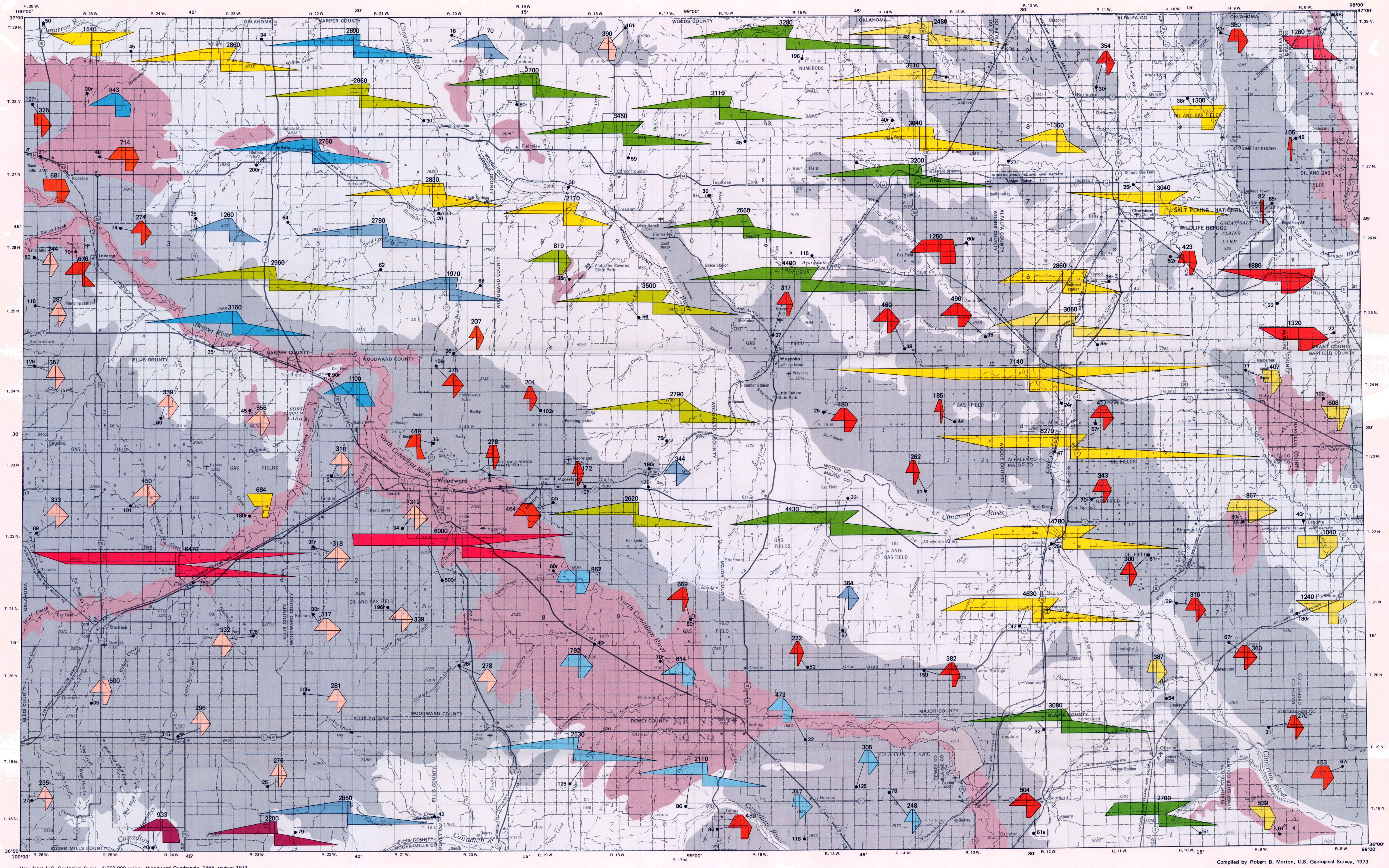


Base from U.S. Geological Survey 1:250,000 series: Woodward Quadrangle, 1955, revised 1971.

Compiled by Robert B. Morton, U.S. Geological Survey, 1973

Scale 1:250,000

DATUM: MEAN SEA LEVEL

FIGURE 5: MAP SHOWING CHEMICAL QUALITY OF GROUND WATER.

EXPLANATION

Chemical quality of water generally good

Dissolved-solids content of ground water in these areas generally less than 500 mg/l.

Chemical quality of water generally fair

Dissolved-solids content of ground water in these areas generally between 500 and 1,000 mg/l.

Chemical quality of water generally poor

Dissolved-solids content of ground water in these areas generally more than 1,000 mg/l.

● 59

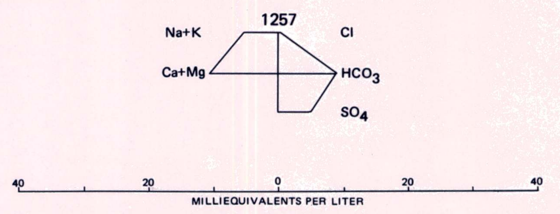
Well

Number is well depth, in feet
r = reported
e = estimated

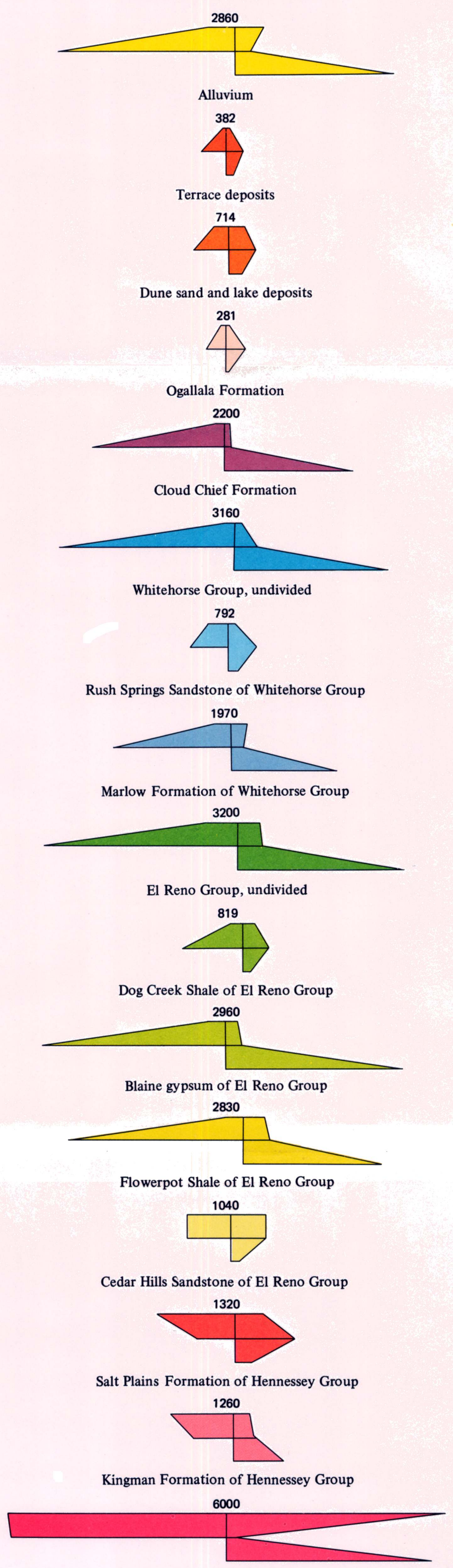
Spring

WATER-QUALITY DIAGRAMS

Diagrams show the general chemical character of ground water and are based on analyses of water from wells or springs at the indicated points. Ionic concentrations in milliequivalents per liter (concentration of a given constituent in milligrams per liter times the reciprocal of its combining weight) are plotted for sodium plus potassium (Na + K), calcium plus magnesium (Ca + Mg), chloride (Cl), bicarbonate (HCO_3), and sulfate (SO_4). Anions are plotted to the right of the center line, and cations to the left. The area of the diagram is an indication of the dissolved-solids content; hence the smaller the area, the less the dissolved-solids content, and, usually, the better the quality of the water. Variations in shape of the diagrams show variations in concentrations of the constituents. Numbers above diagrams are dissolved-solids concentrations, in milligrams per liter.



PROBABLE SOURCES OF WATER



CHEMICAL QUALITY OF GROUND WATER

Data on the chemical quality of ground water in the Woodward Quadrangle are based on water samples collected from 123 wells and one spring and analyzed by the U.S. Geological Survey (fig. 5). Laboratory determinations were made for sodium and potassium, calcium and magnesium, chloride, bicarbonate, sulfate, nitrate, dissolved solids, and hardness.

All ground water contains minerals dissolved mainly from soil and rocks. High concentrations of dissolved minerals may restrict use of water for many purposes. According to the Oklahoma State Department of Health (1964, p. 7), water used for public supplies shall conform to the limits of chemical quality listed in Section 5.2 of the U.S. Public Health Service Drinking Water Standards (1962, p. 7, 8). An exception may be made where it can be demonstrated that no other source is available. The maximum concentrations, in milligrams per liter, recommended by the standards (p. 7) for selected chemical substances are as follows: sulfate (SO_4), 250, chloride (Cl), 250, nitrate (NO_3), 45, and dissolved solids, 500.

Sulfate in ground water is derived from minerals such as gypsum ($CaSO_4 \cdot 2H_2O$) and anhydrite ($CaSO_4$). Water containing sulfate concentration in excessive amounts has an unpleasant taste and also has a laxative effect on most persons. Salts of sulfate are saline cathartics, and a quantity equal to that in 1 liter of water containing 1,000 to 2,000 mg/l (milligrams per liter) sulfate constitutes an average dose (Brown and others, 1970, p. 152). When in combination with calcium, sulfate may cause hard scale in boilers, water heaters, pipes, and plumbing fixtures. Sulfates are less toxic to crops than chlorides.

Chloride is derived from some minerals such as halite, from ancient sea brines trapped in the rocks, and from human, animal, and industrial wastes. Chloride in small amounts has little effect on the usability of water for most purposes, but in concentrations of several hundred milligrams per liter it gives water a salty taste. Small to moderate amounts of chloride may increase the corrosive characteristics of water. Many crops may be injured by waters containing excessive quantities of chloride.

Nitrate is derived from human and animal wastes and from nitrates in the soil. The use of artificial fertilizer increases the amount of nitrate in the soil. Nitrate concentrations greater than 45 mg/l may cause cynanosis due to methemoglobinemia in infants (blue baby); therefore, water with a high nitrate content should not be used for infant feeding or by expectant mothers (U.S. Public Health Service, 1962, p. 50).

Dissolved solids consist principally of the anhydrous residues of dissolved-mineral constituents that remain after a quantity of water has been evaporated by heating. Large amounts of dissolved solids limit the use of water for many purposes.

Hardness in water is objectionable because of its scale-forming properties and because it reduces the cleaning action of soap and detergents. The U.S. Geological Survey (Hem, 1970, p. 225) classifies water having a hardness less than 60 mg/l as soft; 60 to 120 mg/l, moderately hard; 120 to 180 mg/l, hard; and more than 180 mg/l, very hard.

A water-sampling and analysis program designed to prove or disprove contamination from oil- and gas-well brines in the Woodward Quadrangle is beyond the scope of this report. However, some mineralization of ground water in the Woodward Quadrangle may be due to contamination by oil- and gas-well brines, particularly in the vicinity of oil and gas fields. Contamination from any industrial or man-made source usually is the result of improper waste disposal; however, some contamination may result from defective well construction, improper well plugging, and water-flood operations not associated with waste disposal.

Based on limited sampling, the analyses in the statistical summary for each aquifer show that (1) concentrations of dissolved solids tend to be high or exceed the standard in water from all aquifers except the terrace deposits and the Ogallala Formation; (2) generally, concentrations of sulfate in ground water from the alluvium and Marlow Formation of the Whitehorse Group exceed the Public Health Service standard; (3) generally, concentrations of chloride in ground water from the alluvium exceed the standard; (4) with few exceptions, concentrations of nitrate meet the Public Health Service standard in water from all aquifers; and (5) most ground water in the Woodward Quadrangle is very hard.

The rating of the chemical quality of water is an assessment of all constituents present and its expected use; therefore, because the evaluation of ground water from the different aquifers is based on its use as drinking water, waters with a good or fair rating (fig. 5) may or may not be acceptable for irrigation or other industrial or domestic uses.

REFERENCES CITED

Brown, E., Skougstad, M. W., and Fishman, M. J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: Techniques of Water Resources Investigations of the U.S. Geological Survey Book 5, Chapter Al, 160 p.

Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water (2d ed.): U.S. Geological Survey Water-Supply Paper 1473, 358 p.

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Summary of chemical analyses of water from alluvium

CONCENTRATIONS (IN MILLIGRAMS PER LITER)

	MAXIMUM	UPPER QUARTILE 1/	MEDIAN 2/	LOWER QUARTILE 3/	MINIMUM	NUMBER OF ANALYSES
Hardness	2,260	1,840	1,360	455	166	13
Sulfate	3,840	1,975	1,360	430	98	13
Chloride	2,880	470	365	215	90	13
Nitrate	40	17	4	1	0	9
Dissolved solids	7,140	4,705	2,860	1,450	684	13

Summary of chemical analyses of water from terrace deposits

CONCENTRATIONS (IN MILLIGRAMS PER LITER)

	MAXIMUM	UPPER QUARTILE 1/	MEDIAN 2/	LOWER QUARTILE 3/	MINIMUM	NUMBER OF ANALYSES
Hardness	560	295	227	177	31	32
Sulfate	305	74	40	18	6	32
Chloride	135	50	23	11	5	32
Nitrate	210	30	15	8	1	31
Dissolved solids	1,250	463	357	271	82	32

Summary of chemical analyses of water from Ogallala Formation

CONCENTRATIONS (IN MILLIGRAMS PER LITER)

	MAXIMUM	UPPER QUARTILE 1/	MEDIAN 2/	LOWER QUARTILE 3/	MINIMUM	NUMBER OF ANALYSES
Hardness	330	271	243	203	170	20
Sulfate	110	24	17	10	7	20
Chloride	78	27	16	7	4	20
Nitrate	120	22	16	6	0	20
Dissolved solids	556	353	318	283	235	20

Summary of chemical analyses of water from Rush Springs Sandstone of Whitehorse Group

CONCENTRATIONS (IN MILLIGRAMS PER LITER)

	MAXIMUM	UPPER QUARTILE 1/	MEDIAN 2/	LOWER QUARTILE 3/	MINIMUM	NUMBER OF ANALYSES
Hardness	1,900	930	405	205	170	9
Sulfate	1,700	747	162	19	13	9
Chloride	200	68	23	12	6	9
Nitrate	150	20	8	3	1	9
Dissolved solids	2,530	1,486	614	326	248	9

Summary of chemical analyses of water from Marlow Formation of Whitehorse Group

CONCENTRATIONS (IN MILLIGRAMS PER LITER)

	MAXIMUM	UPPER QUARTILE 1/	MEDIAN 2/	LOWER QUARTILE 3/	MINIMUM	NUMBER OF ANALYSES
Hardness	1,900	1,800	870	264	250	7
Sulfate	1,800	1,700	630	25	17	7
Chloride	122	64	35	28	22	7
Nitrate	40	16	8	3	2	7
Dissolved solids	2,850	2,780	1,260	364	344	7

Summary of chemical analyses of water from Whitehorse Group, undivided

CONCENTRATIONS (IN MILLIGRAMS PER LITER)

	MAXIMUM	UPPER QUARTILE 1/	MEDIAN 2/	LOWER QUARTILE 3/	MINIMUM	NUMBER OF ANALYSES
Hardness	1,870	1,865	1,800	600	565	5
Sulfate	1,600	1,600	1,550	288	283	5
Chloride	131	116	70	51	32	5
Nitrate	23				0	3
Dissolved solids	3,160	2,955	2,690	972	843	5

Summary of chemical analyses of water from Cedar Hills Sandstone of El Reno Group

CONCENTRATIONS (IN MILLIGRAMS PER LITER)

	MAXIMUM	UPPER QUARTILE 1/	MEDIAN 2/	LOWER QUARTILE 3/	MINIMUM	NUMBER OF ANALYSES
Hardness	1,900	1,702	394	180	76	10
Sulfate	2,350	1,700	89	31	17	10
Chloride	432	210	114	68	40	10
Nitrate	100	9	6	1	0	9
Dissolved solids	3,660	2,738	954	506	387	10

1/Upper quartile—25 percent of the samples had a value greater than the amount shown, and 75 percent had less.

2/Median—50 percent of the samples had a value greater than the amount shown, and 50 percent had less.

3/Lower quartile—25 percent of the samples had a value less than the amount shown, and 75 percent had more.

RECONNAISSANCE OF THE WATER RESOURCES OF THE WOODWARD QUADRANGLE, NORTHWESTERN OKLAHOMA

By
Robert B. Morton
U.S. Geological Survey

1980