TEXAS
WATER
DEVELOPMENT
BOARD

Report 129

RECONNAISSANCE OF THE CHEMICAL QUALITY OF SURFACE WATERS OF THE RED RIVER BASIN, TEXAS

MAY 1971

TEXAS WATER DEVELOPMENT BOARD

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RECONNAISSANCE OF THE CHEMICAL QUALITY OF SURFACE WATERS OF THE RED RIVER BASIN, TEXAS

By

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RECONNAISSANCE OF THE CHEMICAL QUALITY OF SURFACE WATERS OF THE RED RIVER BASIN, TEXAS

ABSTRACT

The Red River, from its point of origin in eastern New Mexico to the northeast corner of Texas, drains an area of about 48,000 square miles. The total area in Texas is 24,500 square miles. From west to east the topography changes from the nearly flat surface of the High Plains, to a gently eastward-sloping plain dissected by prominent systems of drainage in the Osage Plains, to the low relief and gently gulfward slope of the West Gulf Coastal Plain.

The climate of the basin ranges from semiarid to humid; mean annual precipitation is less than 18 inches in the far western part and more than 46 inches in the extreme eastern part. Runoff increases from about 50 acre-feet per square mile at the 100th meridian to more than 800 acre-feet per square mile in the northeast corner of the State.

The dissolved-mineral content and chemical character of waters in the Red River basin vary widely from place to place and from time to time. Geologic factors, runoff and streamflow characteristics, and activities of man largely determine the nature and amount of dissolved material transported by the Red River and its tributaries. In the semiarid western part of the basin, base flow is usually nonexistent. However, numerous seeps and springs in Permian rocks that crop out in this part of the basin account for much of the salt load in the Red River above Lake Texoma. The water quality of the main stem has been further degraded by oil-field brines. The eastern part of the basin is in an area of high rainfall and well-leached rocks and soils. Ground-water effluent is generally low in dissolved minerals, and the dissolved-solids content of streamflow varies only slightly with discharge.

The highly mineralized waters from salt sources in the western part of the basin cause the water of the Red River to be undesirable for public supply throughout most of its reach in Texas. Storage of good-quality water in existing and proposed reservoirs on tributaries to the Red River will increase degradation of water quality in the main stem, especially above Lake Texoma. Even if releases are made from tributary impoundments in the western part of the basin, evaporation during impoundment and waste water from various uses of the reservoir waters will degrade the tributary waters entering the main stem. For any plan to be effective in the improvement of water quality of Red River throughout its reach in Texas, large amounts of natural brine must be prevented from entering water courses of the basin.

RECONNAISSANCE OF THE CHEMICAL QUALITY OF SURFACE WATERS OF THE RED RIVER BASIN, TEXAS

INTRODUCTION

The investigation of the chemical quality of the surface waters of the Red River basin, Texas, is part of a statewide reconnaissance. Each major river basin in the State is being studied and a report is being prepared to present the results of the study and to summarize the available chemical-quality data. Reports that have been published are included in the list of references.

The purpose of this report is to summarize information on the quality of surface water in the Red River basin, and to present it in a form that will aid in the proper development, control, and use of water resources of the area. In the study, the following items were considered: the nature and amounts of mineral constituents in solution; the geologic, hydrologic, and cultural influences that determine water quality; the amount and probable source of the salt transported by streams; and the suitability of the water for domestic, industrial, and agricultural uses. Data for the Oklahoma part of the Red River basin are included to show the effect of runoff from Oklahoma on the chemical quality of water in the mainstem Red River.

A network of daily chemical-quality stations on principal streams in Texas is operated by the U.S. Geological Survey in cooperation with the Texas Water Development Board and with federal and local agencies. This network has not been adequate to inventory completely the chemical quality of the surface waters of the State. To supplement the information being obtained by the network, a cooperative statewide reconnaissance by the U.S. Geological Survey and Texas Water Development Board was begun in September 1961. In this reconnaissance, samples for chemical analyses have been collected periodically at numerous sites throughout the State so that some quality-of-water information would be available for locations where water-development projects are likely. These data aid in the delineation of areas having water-quality problems and in the identification of probable sources of pollution, and thus indicate areas where more detailed investigations are needed.

During the period September 1961 to September 1967, water-quality data were collected on the principal streams, on the major reservoirs, at a number of potential reservoir sites, and on many tributaries in the basin.

Quality-of-water information for the Oklahoma part of the Red River basin was collected by the U.S. Geological Survey in cooperation with the Oklahoma Water Resources Board. Water-quality data in Texas and Oklahoma have been collected also by the U.S. Public Health Service and the Federal Water Quality Administration.

Agencies that have cooperated in the collection of water-quality and streamflow data include the U.S. Army Corps of Engineers, the Texas State Department of Health, and the city of Wichita Falls.

RED RIVER DRAINAGE BASIN

General Description

The Red River basin in Texas is bounded on the north by the Canadian River basin and on the south by the Brazos, Trinity, and Sulphur River basins. (See Figure 1).

The headwater stream in the Red River basin, Tierra Blanca Creek, rises in the High Plains of eastern New Mexico about 40 miles west of the Texas-New Mexico boundary at an elevation of about 4,800 feet above mean sea level. Tierra Blanca Creek flows eastward across the Texas High Plains and becomes the Prairie Dog Town Fork Red River in eastern Randall County. The Prairie Dog Town Fork Red River flows eastward to the southeast corner of the Texas Panhandle where it becomes the Red River. The Red River flows eastward as the Texas-Oklahoma boundary, then becomes the Texas-Arkansas boundary for about 30 miles before leaving the State. At the northeast corner of Texas, the streambed elevation is about 250 feet.

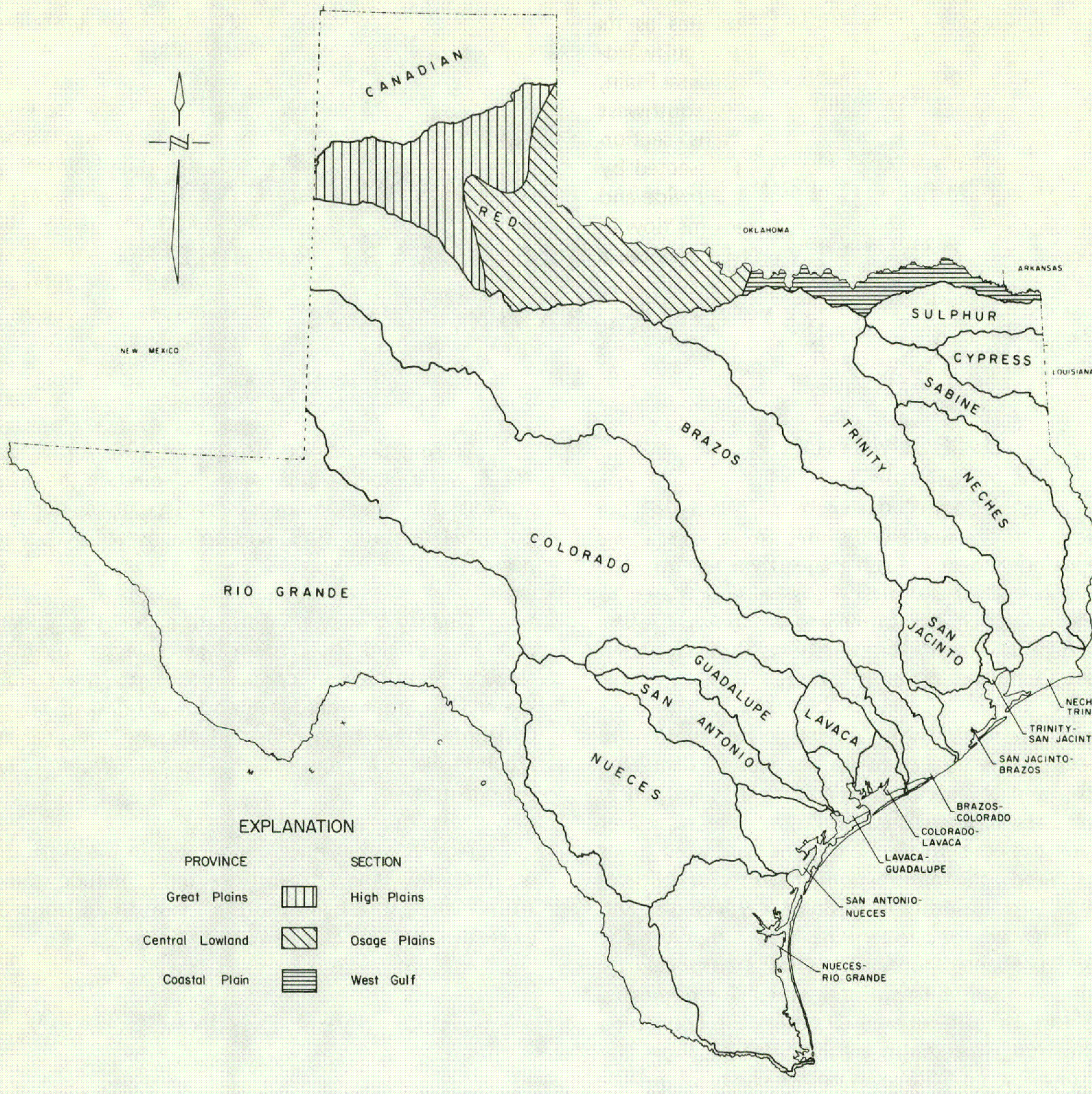


Figure 1.–Drainage Basins in Texas

The Red River has many tributaries in Oklahoma and Texas. The Washita River, Sweetwater Creek, and the North and Salt Forks Red River rise in the Texas Panhandle and flow into Oklahoma before joining the Red River from the north. The major all-Texas tributaries are the Pease, Wichita, and Little Wichita Rivers. Downstream from the Little Wichita River, the Texas part of the basin is narrow and is drained by numerous small streams. The major all-Oklahoma tributaries are Muddy Boggy Creek and the Kiamichi River.

The total area drained by the Red River upstream from the northeast corner of Texas is approximately 48,000 square miles, of which about 5,900 square miles is considered as noncontributing to streamflow. The total area in Texas draining to the Red River is approximately 24,500 square miles of which about 5,300 square miles is considered noncontributing.

The Red River basin in Texas is in three physiographic sections—the High Plains section of the Great Plains province, the Osage Plains section of the Central Lowlands province, and the West Gulf Coastal Plain section of the Coastal Plain province. The physiographic sections are shown on Figure 1.

The High Plains section within the Red River basin is characterized by a nearly flat surface sloping gently southeastward about 10 feet per mile. Among the few and generally insignificant features of relief are saucer-like depressions, ranging in diameter from several tens of feet to about 1 mile, and ranging in depth from a few inches to about 60 feet. The eastern margin of the High Plains is marked by a prominent escarpment or "break of the plains."

The Osage Plains section within the Red River basin adjoins the High Plains section and has as its eastern boundary the western margin of the gulfward-dipping Cretaceous rocks of the West Gulf Coastal Plain, which extends diagonally from northeast to southwest across Montague County. The Osage Plains section generally is a gentle eastward-sloping plain dissected by prominent systems of drainage. The valleys are wide and bounded by abrupt escarpments, and the streams flow in broad, shallow channels. Much of the surface area has a definite reddish color.

The West Gulf Coastal Plain section extends from the edge of the Osage Plains section eastward throughout the remainder of the report area. Low relief and a gentle gulfward slope of the land surface characterizes this section. Local topographic features are irregular, rolling, and hilly uplands, and flat flood plains and terraces. The streams have wide, nearly flat flood plains bounded by a series of terraces, which may be more than 100 feet higher than the stream channels.

The climate of the basin ranges from semiarid to humid (Thornthwaite, 1952, p. 32). Thornthwaite's classification, which is based on a moisture index, compares potential evapotranspiration with precipitation. Where precipitation is exactly the same as potential evapotranspiration and water is available just as needed, water is neither deficient nor in excess, and the climate is neither moist or dry. As water deficiency becomes larger with respect to potential evapotranspiration, the climate becomes more arid; conversely, as water surplus becomes larger, the climate becomes more humid.

East of a north-south line near the Cooke-Montague County line, the basin has surplus moisture and is characterized by a moist subhumid to humid climate. West of this line the area is deficient in moisture and has a dry subhumid to semiarid climate.

Precipitation ranges from an annual mean of less than 18 inches in the far western part of the basin to more than 46 inches in the extreme eastern part.

Figure 2 shows the average monthly precipitation at Amarillo, Wichita Falls, and Sherman, Texas, and McAlester, Oklahoma; it also shows the annual precipitation for 1937-65 at Altus, Oklahoma. In general, precipitation is greatest during the spring and summer months and least during the winter. However, precipitation is more evenly distributed throughout the year in the eastern part of the basin than in the western part.

Runoff is that part of precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man in or on stream channels (Langbein and Iseri, 1960, p. 17). However, the terms are not synonymous for regulated flow. The Red River is regulated by Lake Texoma, and some of the tributary streams are regulated by reservoirs, floodwater-retarding structures, and farm ponds. However, many streams in the Red River basin are not regulated by reservoirs of appreciable size.

The 28-year record of the Salt Fork Red River at Mangum, Oklahoma, is the only long-term record of flow from west of the 100th meridian. Runoff varies widely from year to year, and at the Mangum station has varied from a maximum of 200,400 acre-feet in 1941 to a minimum of 8,930 acre-feet in 1940. Annual average runoff is 0.9 inch (50 acre-feet per square mile) at this station. Runoff at Mangum is indicative of runoff from the area west of the 100th meridian.

Runoff in the Red River basin in Texas increases more or less uniformly from west to east, and averages more than 15 inches per year (800 acre-feet per square mile) at the northeast corner of the State. For the period 1944-65, the average runoff was 15.8 inches per year at the U.S. Geological Survey stream-gaging station Boggy Creek near Daingerfield in nearby Cypress Creek basin. Average annual runoff in inches per year, as computed from streamflow records for the period 1938-66, is given for seven stations on Figure 2. Also shown on Figure 2 is annual runoff expressed as mean discharge in cubic feet per second and inches per year for the gaging stations Salt Fork Red River at Mangum, Oklahoma; Red River near Gainesville, Texas; and Red River at Index, Arkansas.

Population and Municipalities

The Red River basin in Texas constitutes about 9 percent of the area of the State and has about 4 percent of the population. Much of the land is sparsely populated. Population changes within the basin reflect the national trend of rural area decline and urban area increase. As in other areas of the country, these changes are due to the reduction of farm employment opportunities resulting from the development of mechanized, large-scale agricultural methods, and the consequent exodus of surplus farm labor to cities, as well as other migration and social factors. The larger cities have continued to grow while the population of small towns has remained fairly constant. The cities and towns having populations over 2,500 are listed in the following table.

CITY	*POPULATION	CITY	*POPULATION
Amarillo1/	164,770	Bonham	7,600
Wichita Falls	113,800	Tulia	6,690
Sherman	27,100	Childress	6,420
Paris	24,000	Iowa Park	5,410
Denison	23,400	Shamrock	3,420
Vernon	13,980	Nocona	3,360
Hereford	12,570	Henrietta	3,200
Burkburnett	8,490	Whitesboro	2,980

* 1967 population estimates (Dallas Morning News, 1967).

1/ Amarillo is partly in the Canadian River basin.

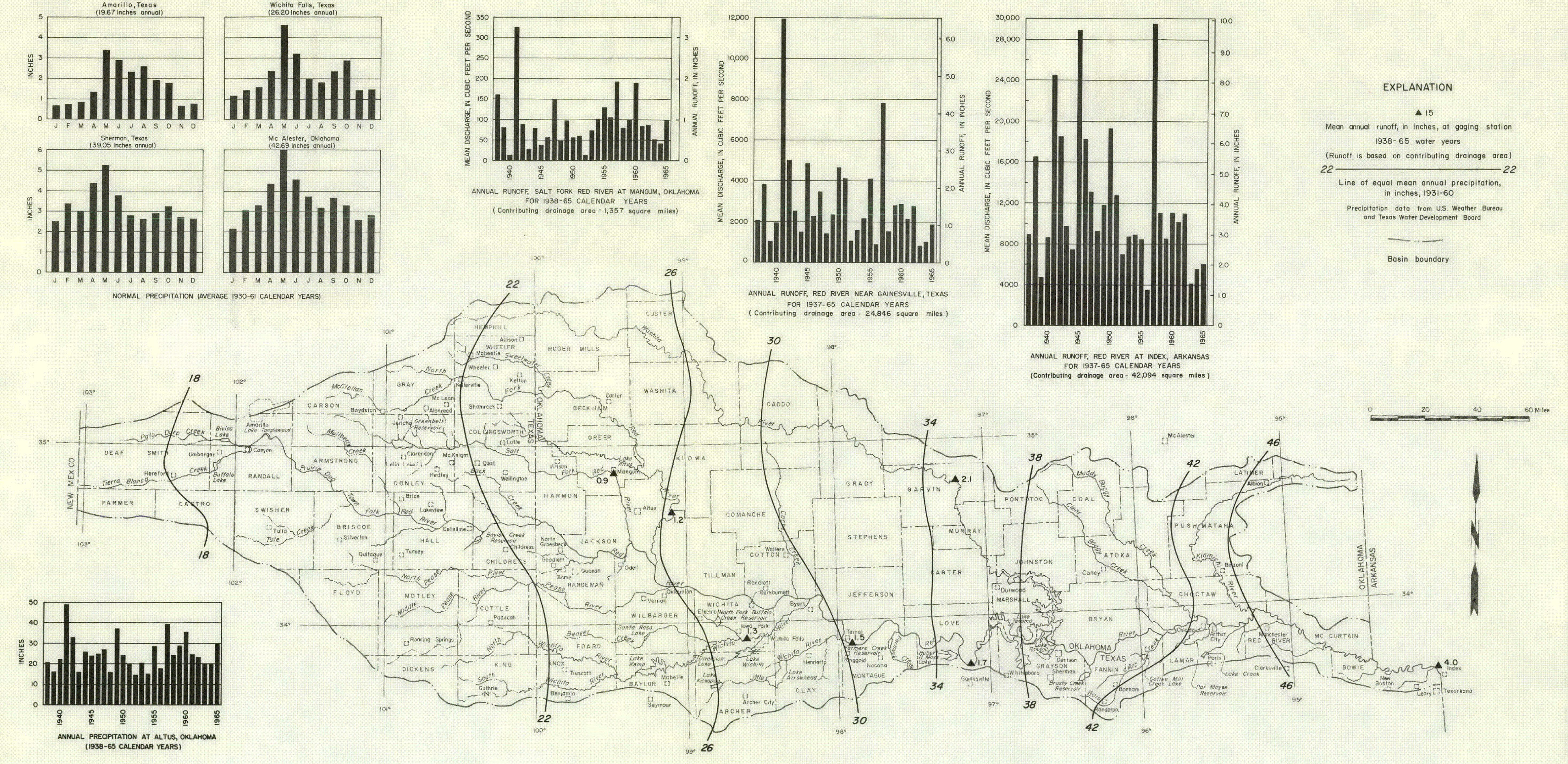


Figure 2

Precipitation and Runoff in the Red River Basin

Base from U.S. Geological Survey, 1:1,000,000

Agricultural and Industrial Development

Agriculture has contributed substantially to the economic growth of the Red River basin. Farming, livestock raising, and dairying are successful because of the fertile soils and generally favorable climate. The availability of ground water for irrigation and the advent of mechanized farm equipment have been largely responsible for the success of farming in the drier western part of the basin. In the eastern part, where rainfall is greater, supplemental irrigation insures good crop yields. Cotton, grain sorghums, and wheat are the principal crops in the western part, and cotton, corn, and vegetables predominate in the eastern part.

The processing of local farm products is one of the major industries in the basin; processing plants are located close to areas of agricultural production. Oil and gas production constitutes another substantial income-producing segment of the economy. Much of the industrial development of the basin is related to the production of oil and gas. The development of irrigation in places has been greatly facilitated by the abundant supply of natural gas for power. Industries in the area that depend on the production of oil and gas include synthetic rubber, carbon black, oil refining, petrochemical, and pipeline equipment. Lumber mills, plants related to timber production, power plants, machinery, and furniture manufacturers are also located in the basin.

Development of Surface-Water Resources

The only reservoir on the Red River is Lake Texoma, which was built for flood control and hydroelectric power generation. Because of the poor quality of the water of the main stem, most of the water development projects in the basin are on tributary streams. As of December 31, 1967, nineteen reservoirs in the Texas part of the basin had capacities of 5,000 acre-feet or more. The capacity, ownership, and use of these reservoirs are listed in Table 1; the locations are shown on Figure 11.

CHEMICAL QUALITY OF THE WATER

Chemical-Quality Records

Although the U.S. Geological Survey has collected chemical-quality records in the Red River basin, Texas, since 1942, very few long-term daily records are available. In 1942, a daily sampling station was established on the Pease River near Crowell, but it was discontinued in 1943. Daily chemical-quality records of more than 10 years are available for the stations at Red River near Gainesville and Red River at Denison Dam. Since 1942, the U.S. Geological Survey has collected daily chemical-quality data for varying periods at 12 stations either on the main stem or on Texas tributaries. In addition, miscellaneous chemical-quality data are available for numerous sites.

The periods of record at all data-collection sites in Texas are given in Table 4 and the locations are shown on Figure 11. The chemical-quality data for the daily stations are summarized in Table 5, and the complete records are published in an annual series of U.S. Geological Survey Water-Supply Papers and in reports of the Texas Water Development Board and predecessor agencies. Results of all the miscellaneous analyses are given in Table 6. Chemical analyses from selected stations in Oklahoma are given in Table 7. Complete records of all chemical-quality data available for surface water in Oklahoma are published in the annual series of U.S. Geological Survey Water-Supply Papers and in reports of the Oklahoma Water Resources Board. See list of references.

Chemical-quality records, including continuous specific conductance data, were collected by the U.S. Public Health Service (1964) at 27 sites in the Red River basin in Texas and Oklahoma during 1961-62. Public Health Service sampling sites in the Red River basin in Texas are identified in Table 4.

The Texas State Department of Health has made available to the Geological Survey the data collected in its former statewide stream-sampling program. The former data-collection sites are listed in the following table. Some of them are at U.S. Geological Survey stream-gaging stations. The numbers refer to sites shown on Figure 11.

SITE NO.	FORMER TEXAS STATE DEPARTMENT OF HEALTH DATA-COLLECTION SITES
4	Palo Duro Creek at Park Road 5 near Canyon, Texas.
13	Prairie Dog Town Fork Red River at State Highway 70 near Brice, Texas.
22	Prairie Dog Town Fork Red River at U.S. Highway 83 near Childress, Texas.
24	Red River at State Highway 283 near Quanah, Texas.
–	Red River at U.S. Highway 183 near Oklaunion, Texas.
68	Red River at U.S. Highway 281 near Burkburnett, Texas.
–	Red River at State Highway 79 near Byers, Texas.

SITE NO.	FORMER TEXAS STATE DEPARTMENT OF HEALTH DATA-COLLECTION SITES
97	Red River at U.S. Highway 81 near Terral, Oklahoma.
99	Red River near Gainesville, Texas.
—	Red River near Denison, Texas.
—	Red River at State Highway 78 near Bonham, Texas.
104	Red River at U.S. Highway 271 near Arthur City, Texas.
—	Red River at State Highway 37 at Albion, Texas.
—	Red River at U.S. Highway 59 near Texarkana, Texas.

Streamflow Records

Streamflow records in the Red River basin date from the 1890's, when the U.S. Weather Bureau began collecting gage-height records on the Red River at Arthur City in 1891 and on the Red River near Colbert, Oklahoma (near Denison, Texas) in 1892. The first Geological Survey gaging station was established on the Wichita River at Wichita Falls in 1900. Discharge records are available for more than 50 stations on the Red River and its tributaries in Texas; 11 stations have 15 years or more of record and several others have more than 5 years of record.

In 1966 the Geological Survey operated 26 streamflow stations, five reservoir content stations, and five partial-record stations in the Red River basin, Texas. During this reconnaissance, discharge measurements were made at other sites where water samples were collected for chemical analyses.

Records of discharge, stage of streams, and contents and stages of reservoirs from 1900 to 1960 have been published in the annual series of the U.S. Geological Survey Water-Supply Papers. Beginning with the 1961 water year, streamflow records have been released by the Geological Survey in annual reports for each state (U.S. Geological Survey, 1961, 1962, 1963, 1964b, 1965, 1966). Summaries of discharge records giving monthly and annual totals have been published (U.S. Geological Survey 1955, 1964a; Texas Board of Water Engineers, 1958).

Environmental Factors and Their Effects on the Chemical Quality of the Water

Water from natural sources contains mineral constituents dissolved from the rocks and soils of the earth's crust. The kind and quantities of dissolved minerals in surface water depend upon a number of environmental factors, some of the most important of which are geology, streamflow characteristics, and the activities of man.

Geology

The amounts and kinds of minerals dissolved in water that drains from areas where municipal and industrial influences are small depend principally on the chemical composition and physical structure of the rocks and soils traversed by the water. The length of time the water is in contact with the soil and rocks is also important. The amount of minerals in the soils and rocks available for solution is decreased by leaching; therefore, in areas of high rainfall, rocks that originally contained large quantities of readily soluble minerals have been leached by circulating water until the mantle rock and residual soil contain relatively small amounts of readily soluble materials. These rocks usually yield water of low mineralization. However, in arid or semiarid regions most soils, and the rocks from which they originated, are incompletely leached and still contain large amounts of readily soluble material.

In the semiarid western part of the Red River basin, some rocks and soils contain large quantities of halite, gypsum, limestone, and dolomite. Water of streams draining these areas usually is highly mineralized. In the eastern part of the basin, where precipitation is more abundant, the well-leached rocks usually yield waters of low mineralization.

The geology of the Red River basin, Texas, has been described by Baker and others (1963, p. 18-26). Rocks exposed in the Texas part of the basin consist of a thick series of sedimentary strata that range in age from Pennsylvanian to Quaternary. The outcrop areas of the geologic units are shown on Figure 3.

Chemical analyses of selected low-flow samples are represented diagrammatically (Stiff, 1951) on Figure 3 to relate chemical composition of surface waters to geology. The shape of the diagram indicates the relative concentrations of the principal chemical constituents of the water (in milliequivalents per liter) and the size of the diagram indicates roughly the relative degree of mineralization.

The headwater stream of the Red River rises in the Ogallala Formation of Tertiary age. The Ogallala consists of clay, silt, sand, gravel, and caliche. Some of the sand, gravel, and silt are unconsolidated; but some cementation occurs, chiefly by calcium carbonate. The principal chemical constituents in water from the Ogallala are sodium, calcium, magnesium, and bicarbonate. Base flow is generally nonexistent in streams that drain the Ogallala outcrop, and runoff occurs only after heavy rains.

Table 1.—Reservoirs in the Red River Basin in Texas Having Capacities of 5,000 Acre-Feet or More.1/

(The purpose for which the impounded waters are used is indicated by the following symbols: M, municipal; I, industrial; Ir, irrigation; P, hydroelectric power; F, flood control; R, recreation.)

RESERVOIR	DATE COMPLETED	STREAM	*CAPACITY (AC-FT)	OWNER	COUNTY	USE
Buffalo Lake	1938	Tierra Blanca Creek	18,150	Fish and Wildlife Service, U.S. Department of Interior	Randall	R
Bivins Lake	1927	Palo Duro Creek	5,120	City of Amarillo	Randall	M
Baylor Creek	1950	Baylor Creek	9,220	City of Childress	Childress	M
Greenbelt	1966	Salt Fork Red River	59,800	Greenbelt Municipal and Industrial Water Authority	Donley	M, I
Lake Kemp	1923	Wichita River	461,800	City of Wichita Falls and Wichita County Water Improvement District No. 2	Baylor	I, Ir
Diversion Lake	1924	do	40,000	do	Baylor, Archer	I, Ir
Santa Rose Lake	1929	Beaver Creek	11,570	W. T. Waggoner Estate	Wilbarger	I, Ir
North Fork Buffalo Creek	1964	North Fork Buffalo Creek	15,400	Wichita County Water Control and Improvement District No. 3	Wichita	M
Lake Wichita	1901	Holliday Creek	14,000	City of Wichita Falls	Wichita, Archer	M
Lake Kickapoo	1945	North Fork Little Wichita River	106,000	do	Archer	M
Lake Arrowhead	1966	Little Wichita River	228,000	do	Archer, Clay	M, I
Farmers Creek	1960	Farmers Creek	25,400	North Montague County Water Supply District	Montague	M, I
Hubert H. Moss Lake	1966	Fish Creek	23,200	City of Gainesville	Cooke	M, I
Lake Texoma	1943	Red River	5,393,000	U.S. Army Corps of Engineers	Cooke, Grayson	P, F
Lake Randall	1909	Shawnee Creek	5,400	City of Denison	Grayson	M
Brushy Creek	1961	Brushy Creek	16,800	Texas Power and Light Co.	Fannin, Grayson	I
Coffee Mill Creek Lake	1938	Coffee Mill Creek	8,000	U.S. Forest Service	Fannin	R
Pat Mayse	1967	Sanders Creek	124,500	U.S. Army Corps of Engineers	Lamar	M, I, F
Lake Crook	1923	Pine Creek	9,960	City of Paris	Lamar	M

1/ Existing or under construction as of December 31, 1967.

* Total capacity is that capacity below the lowest uncontrolled outlet or spillway and is based on the most recent reservoir survey available.

Downstream from the Ogallala outcrop, the drainage area of the Prairie Dog Town Fork Red River is underlain by rocks of Triassic and Permian age. The Dockum Group of Triassic age consists of shale and sandy shale, crossbedded sandstone, and conglomerate. The chemical quality of the water from the Dockum Group varies with local conditions, but it is generally unsuitable for irrigation or public supply.

Rocks of Permian age crop out over much of the basin east of the High Plains Escarpment and west of the eastern boundary of Montague County. The Permian rocks consist predominantly of shale, anhydrite, gypsum, limestone, dolomite, and sandstone. The chemical composition of water contributed to streams by these rocks varies. During periods of sustained low flow, water of the Prairie Dog Town Fork Red River, and the North and Salt Forks Red River is of a highly mineralized calcium sulfate type. Water of the Pease River and North and South Forks Wichita River is of a highly mineralized sodium chloride type. Significant natural brine emission areas as identified by the U.S. Public Health Service (1964) are shown on Figure 4. Numerous small alluvial deposits of Quaternary age are present in this area, and ground-water flow from them probably causes some of the variations in chemical composition and dissolved-solids concentration of surface waters.

Downstream from Lake Kemp, the Wichita River drains rocks of the Wichita Group of Permian age. The Wichita Group consists of shale, sandstone, and limestone. Ground-water effluent in this reach is generally of a mixed chemical type having sodium, sulfate, and chloride as the predominant ions. Dissolved-solids concentrations are much less than those of waters above Lake Kemp.

The drainage area of the Little Wichita River is underlain by rocks of the Cisco and Wichita Groups. The Cisco Group of Pennsylvanian age is composed of shale, limestone, sandstone, and conglomerate. Ground-water effluent in Little Wichita River watershed is generally of a mixed chemical type, having sodium, bicarbonate, and chloride as the predominant ions; the water is relatively low in dissolved solids. However, oil-field brine pollution in some reaches in the Wichita and Little Wichita Rivers has in the past altered the composition of water to a sodium chloride type.

Downstream from the Montague-Cooke County line, the streams drain rocks of Cretaceous age. The principal outcrops are the Eagle Ford Shale consisting of shale, limestone, and sand; rocks of Austin age consisting of chalk, marl, and sand; rocks of Taylor age consisting of marl, chalk, and sandy marl; and the Washita and Fredericksburg Groups undifferentiated consisting of limestone, marl, and clay. Waters draining these rocks, although varying slightly in composition from one formation to another, are low in dissolved-solids content and usually contain calcium and bicarbonate as the predominant ions. Quaternary alluvium is exposed from Lake Texoma eastward to the northeast corner of Texas. However, these alluvial deposits are present along the river in the form of terraces which hold water in bank storage. The alluvium is recharged during high flow, but it releases the water to the river when the high flow subsides.

Streamflow

For many streams not regulated by upstream reservoirs, the concentrations of dissolved minerals vary inversely with the water discharge. The minimum concentrations usually occur during periods of high flow because most of the water is surface runoff that has been in contact with rocks and soils for a relatively short time. The maximum concentrations usually occur during periods of low flow when the water is predominantly ground water that has been in contact with the rocks and soils for a sufficient time to dissolve part of their soluble minerals.

In the western part of the Red River basin, dissolved-solids content and water discharge are not related in a predictable manner. Many of the streams are dry or almost dry much of the time, and salt deposits accumulate on the beds and banks of the streams. Subsequent runoff dissolves these deposits causing erratic variation in the salt content of the runoff.

In the eastern part of the basin, the dissolved-solids content of ground-water effluent is generally low, and therefore the dissolved-solids content of streams varies only slightly with discharge. Consequently, the dissolved solids-water discharge relationship is poorly defined for streams in the Red River basin in Texas.

Activities of Man

The activities of man often degrade the chemical quality of surface water. Depletion of flow by diversion and by consumptive use, increased evaporation from impoundment, and return flow from irrigation increase the dissolved-solids concentration of water in streams. Also, the discharge of municipal and industrial wastes into a stream degrades the chemical quality of water.

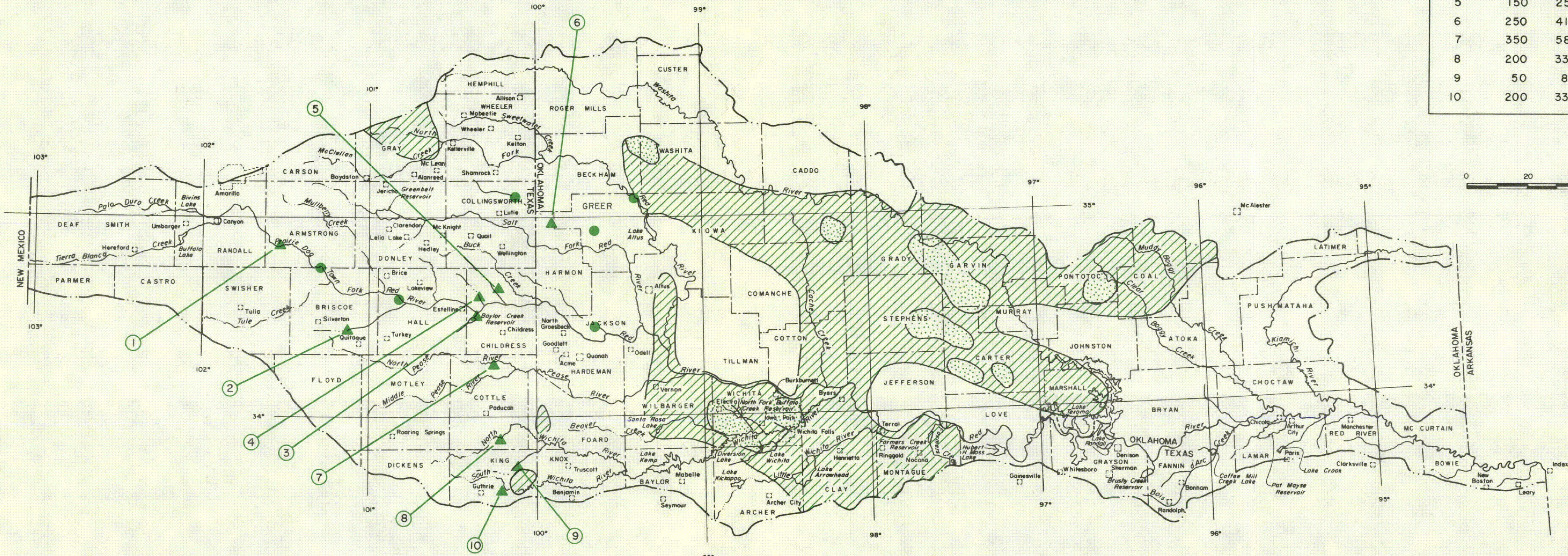
Eighteen reservoirs presently impound water of Texas tributaries to the Red River (Table 1). All of these except Lake Kemp, Diversion Lake, and Lake Wichita contain waters of good to excellent quality. Because these waters are stored and prevented from reaching the river, the quality of water of the main stem has been degraded to some extent. Much of the lake water eventually returns to the river system, but its quality has been affected by evaporation and other hydrologic changes due to impoundment. Most often the water

EXPLANATION

- General area of petroleum and natural gas production (hatched)
- Area of intensive petroleum production (stippled)
- ① ▲ Significant natural brine emission area
- ● Secondary natural brine emission area

Contribution of significant natural brine emission areas

Area No.	Load-tons/day average Cl	Load-tons/day average NaCl	Estimated brine flow Cfs
1	175	290	2
2	150	250	1
3	375	620	5
4	450	740	4
5	150	250	2
6	250	410	1
7	350	580	2
8	200	330	2
9	50	80	1
10	200	330	2



Base from U.S. Geological Survey, 1:1,000,000

Figure 4

Location of Natural Brine Emissions and Areas of Petroleum Production

Adapted from Arkansas-Red River Basins, Water Quality Conservation, U.S. Public Health Service, 1964, Figures 2 and 9

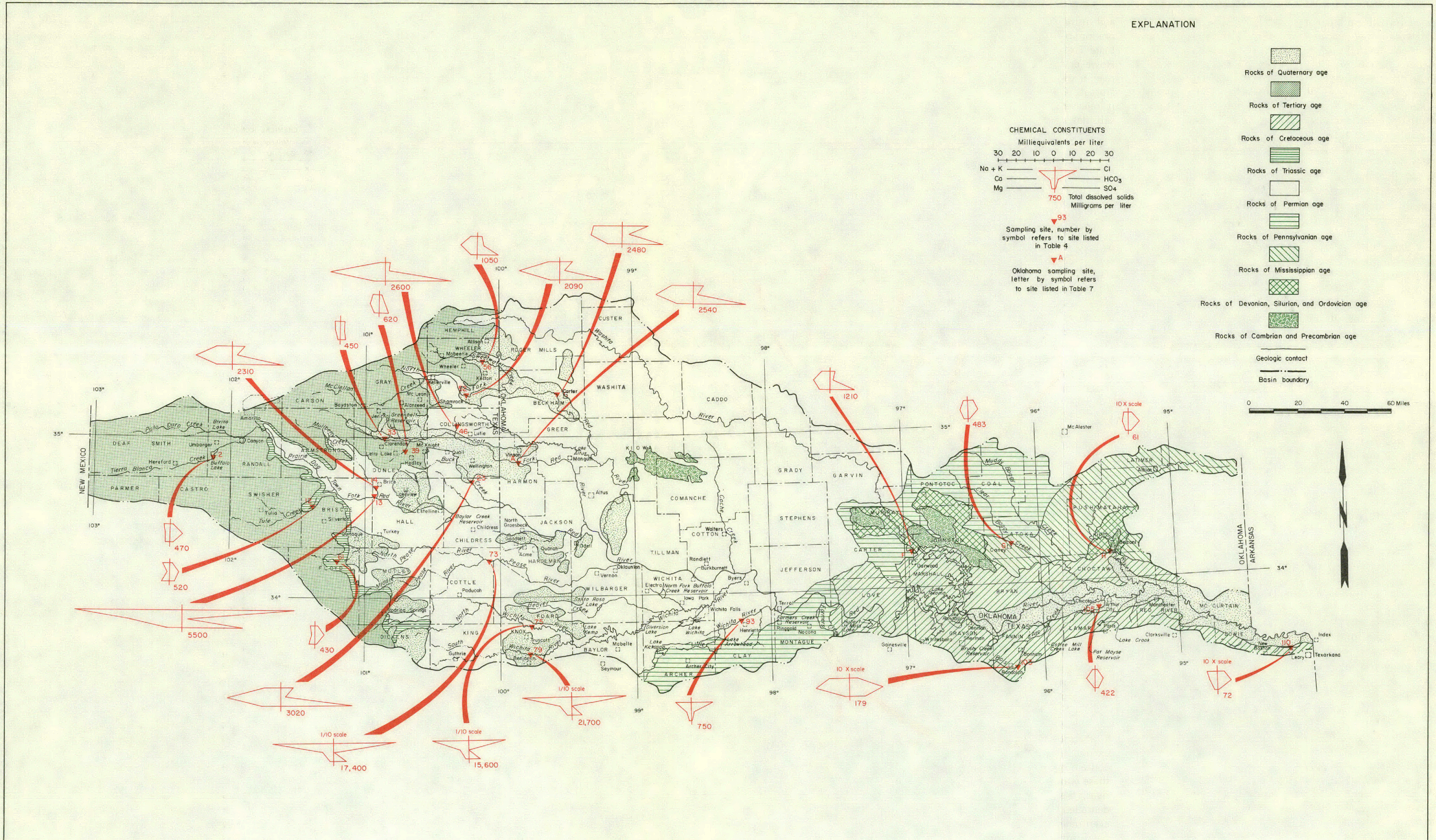


Figure 3

Geologic Map and Chemical Composition of Low-Flow of Streams

Base from U.S. Geological Survey 1:1,000,000, 1957

Geology modified from geologic map of the United States (Stose and Ljungstedt, 1932)

diverted from the lakes returns to the river system as waste water from municipal, industrial, and agricultural uses. As the needs for more water and number of reservoirs increase, the quality-of-water problems of the main stem may increase.

At present, degradation of water quality by return flow from irrigation in the Red River basin, Texas is considered minor and localized. Although 1.4 million acres in the basin was irrigated with over 2 million acre-feet of water in 1964, more than 95 percent of both the land irrigated and the water used was in the Texas Panhandle (Gillett and Janca, 1965). Nearly all of the Panhandle supply is from ground water; the Ogallala Formation supplied about 1.5 million acre-feet of water to irrigate approximately a million acres in the High Plains. Irrigation return flow contributes very little to streamflow in the Panhandle, and any flow that does reach a stream probably will enhance rather than degrade the quality of the natural saline waters in most areas. The use of surface water for irrigation is limited primarily to the Wichita Falls area and the area along the Red River north of Texarkana. Minor, localized degradation of small tributaries to the Red River may be occuring in these areas.

Oil is produced in many areas in the Red River basin (Figure 4). Brine is produced in nearly all oil fields and, if improperly handled, eventually reaches surface streams. According to an inventory by the Texas Railroad Commission in 1961, more than 95 percent of the salt water produced in oil fields of the Red River basin, Texas, was injected underground (Texas Water Commission and Texas Water Pollution Control Board, 1963). The remainder of the salt water was disposed of in open surface pits, most of which were unlined. From these surface pits, much of the brine has seeped into the ground and eventually reaches the streams, or it is washed by surface runoff directly into the streams. Also, brine from abandoned wells and unplugged or improperly plugged test holes may reach streams.

The composition of oil-field brine varies, but the principal chemical constituents, in order of magnitude of their concentrations, are chloride, sodium, calcium, and sulfate. Generally, an erratic variation of the sodium chloride content of water in streams draining areas where oil fields are located is evidence that oil-field brine pollution is occurring. Because of widespread contamination of streams in the Red River basin by naturally occurring sodium chloride brines, distinction between natural contamination and manmade pollution is difficult. However, the saline waters of several streams in the central part of the basin have contained salts from both natural sources and oil fields. Chemical-quality records indicate that several streams, not affected by naturally occurring brines, have periodically shown effects of oil-field drainage. Generally, these streams are in the Beaver Creek, Buffalo Creek, and Little Wichita River sub-basins.

Relation of Quality of Water to Use

Quality-of-water studies usually are concerned with determining the suitability of water—judged by the chemical, physical, and biological characteristics—for a proposed use. In the Red River basin, surface water is used for municipal and industrial supplies and for irrigation. This report considers only the chemical character of the water and its relation to these principal uses.

Most of the mineral matter dissolved in water is dissociated into charged particles, or ions. Principal cations (positive charged) in natural water are calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and iron (Fe). The principal anions (negative charged) are carbonate (CO_3), bicarbonate (HCO_3), sulfate (SO_4), chloride (Cl), fluoride (F), and nitrate (NO_3). Other constituents and properties are often determined to help define the chemical and physical quality of water. Table 2 lists the constituents and properties commonly determined by the U.S. Geological Survey, and includes a résumé of their source and significance.

Domestic Use

Because of differences in individuals, varying amounts of water consumed, and other factors, it is difficult to define the safe limits for the mineral constituents usually found in water. The limits usually accepted in the United States for drinking water are the drinking-water standards established by the United States Public Health Service. Originally established in 1914 to control the quality of water used on interstate carriers for drinking and culinary purposes, these standards have been revised several times. The latest revision was in 1962 (U.S. Public Health Service, 1962). These standards have been accepted by the American Water Works Association and by many state departments of public health as minimum standards for all public water supplies.

The maximum concentrations permitted by the standards are given for selected constituents in the following table:

CONSTITUENTS	MAXIMUM CONCENTRATION (MILLIGRAMS PER LITER)
Sulfate	250
Chloride	250
Nitrate	45
Fluoride	[a]0.9
Dissolved solids	500

[a] Recommended limits based on the average of maximum daily air temperatures. Concentration cited is the optimum based on temperature records for Iowa Park.

Table 2.—Source and Significance of Dissolved-Mineral Constituents and Properties of Water

CONSTITUENT OR PROPERTY	SOURCE OR CAUSE	SIGNIFICANCE
Silica (SiO_2)	Dissolved from practically all rocks and soils, commonly less than 30 mg/l. High concentrations, as much as 100 mg/l, generally occur in highly alkaline waters.	Forms hard scale in pipes and boilers. Carried over in steam of high pressure boilers to form deposits on blades of turbines. Inhibits deterioration of zeolite-type water softeners.
Iron (Fe)	Dissolved from practically all rocks and soils. May also be derived from iron pipes, pumps, and other equipment. More than 1 or 2 mg/l of iron in surface waters generally indicates acid wastes from mine drainage or other sources.	On exposure to air, iron in ground water oxidizes to reddish-brown precipitate. More than about 0.3 mg/l stains laundry and utensils reddish-brown. Objectionable for food processing, textile processing, beverages, ice manufacture, brewing, and other processes. U.S. Public Health Service (1962) drinking-water standards state that iron should not exceed 0.3 mg/l. Larger quantities cause unpleasant taste and favor growth of iron bacteria.
Calcium (Ca) and magnesium (Mg)	Dissolved from practically all soils and rocks, but especially from limestone, dolomite, and gypsum. Calcium and magnesium are found in large quantities in some brines. Magnesium is present in large quantities in sea water.	Cause most of the hardness and scale-forming properties of water; soap consuming (see hardness). Waters low in calcium and magnesium desired in electroplating, tanning, dyeing, and in textile manufacturing.
Sodium (Na) and potassium (K)	Dissolved from practically all rocks and soils. Found also in ancient brines, sea water, industrial brines, and sewage.	Large amounts, in combination with chloride, give a salty taste. Moderate quantities have little effect on the usefulness of water for most purposes. Sodium salts may cause foaming in steam boilers and a high sodium content may limit the use of water for irrigation.
Bicarbonate (HCO_3) and carbonate (CO_3)	Action of carbon dioxide in water on carbonate rocks such as limestone and dolomite.	Bicarbonate and carbonate produce alkalinity. Bicarbonates of calcium and magnesium decompose in steam boilers and hot water facilities to form scale and release corrosive carbon dioxide gas. In combination with calcium and magnesium, cause carbonate hardness.
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Commonly present in mine waters and in some industrial wastes.	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfate in combination with other ions gives bitter taste to water. Some calcium sulfate is considered beneficial in the brewing process. U.S. Public Health Service (1962) drinking-water standards recommend that the sulfate content should not exceed 250 mg/l.
Chloride (Cl)	Dissolved from rocks and soils. Present in sewage and found in large amounts in ancient brines, sea water, and industrial brines.	In large amounts in combination with sodium, gives salty taste to drinking water. In large quantities, increases the corrosiveness of water. U.S. Public Health Service (1962) drinking-water standards recommend that the chloride content should not exceed 250 mg/l.
Fluoride (F)	Dissolved in small to minute quantities from most rocks and soils. Added to many waters by fluoridation of municipal supplies.	Fluoride in drinking water reduces the incidence of tooth decay when the water is consumed during the period of enamel calcification. However, it may cause mottling of the teeth, depending on the concentration of fluoride, the age of the child, amount of drinking water consumed, and susceptbility of the individual. (Maier, 1950)
Nitrate (NO_3)	Decaying organic matter, sewage, fertilizers, and nitrates in soil.	Concentration much greater than the local average may suggest pollution. U.S. Public Health Service (1962) drinking-water standards suggest a limit of 45 mg/l. Waters of high nitrate content have been reported to be the cause of methemoglobinemia (an often fatal disease in infants) and therefore should not be used in infant feeding. Nitrate has been shown to be helpful in reducing inter-crystalline cracking of boiler steel. It encourages growth of algae and other organisms which produce undesirable tastes and odors.
Dissolved solids	Chiefly mineral constituents dissolved from rocks and soils. Includes some water of crystallization.	U.S. Public Health Service (1962) drinking-water standards recommend that waters containing more than 500 mg/l dissolved solids not be used if other less mineralized supplies are available. Waters containing more than 1000 mg/l dissolved solids are unsuitable for many purposes.
Hardness as $CaCO_3$	In most waters nearly all the hardness is due to calcium and magnesium. All the metallic cations other than the alkali metals also cause hardness.	Consumes soap before a lather will form. Deposits soap curd on bathtubs. Hard water forms scale in boilers, water heaters, and pipes. Hardness equivalent to the bicarbonate and carbonate is called carbonate hardness. Any hardness in excess of this is called non-carbonate hardness. Waters of hardness as much as 60 ppm are considered soft; 61 to 120 mg/l, moderately hard; 121 to 180 mg/l, hard; more than 180 mg/l, very hard.
Specific conductance (micromhos at 25°C)	Mineral content of the water.	Indicates degree of mineralization. Specific conductance is a measure of the capacity of the water to conduct an electric current. Varies with concentration and degree of ionization of the constituents.
Hydrogen ion concentration (pH)	Acids, acid-generating salts, and free carbon dioxide lower the pH. Carbonates, bicarbonates, hydroxides, and phosphates, silicates, and borates raise the pH.	A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increasing alkalinity; values lower than 7.0 indicate increasing acidity. pH is a measure of the activity of the hydrogen ions. Corrosiveness of water generally increases with decreasing pH. However, excessively alkaline waters may also attack metals.

Industrial Use

The quality requirements vary greatly for almost every industrial application, as is indicated by the water-quality tolerances given in Table 3. One requirement of most industries is that concentrations of the various constituents of the water remain relatively constant. When concentrations of undesirable substances in water vary, constant monitoring is required and operating expenses are increased.

Hardness is one of the more important properties of water that affects its utility for industrial purposes. Excessive hardness is objectionable because it contributes to the formation of scale in steam boilers, pipes, water-heaters, radiators, and various other equipment where water is heated, evaporated, or treated with alkaline materials. The accumulation of scale increases costs for fuel, labor, repairs and replacement, and lowers the quality of many wet-processed products. However, some calcium hardness may be desirable because calcium carbonate sometimes forms protective coatings on pipes and other equipment and reduces corrosion.

The corrosive property of water receives considerable attention in industrial water supplies. A high concentration of dissolved solids in a water may be closely associated with the corrosiveness, particularly if chloride is present in appreciable quantities. Water that contains a large concentration of magnesium chloride may be highly corrosive because the hydrolysis of this salt yields hydrochloric acid.

Irrigation

The chemical composition of a water is an important factor in determining its usefulness for irrigation, because the quality of the water should not adversely affect the productivity of the land irrigated. The extent to which chemical quality limits the suitability of a water for irrigation depends on many factors, such as the nature, composition, and drainage of the soil and subsoil; the amounts of water used and the methods of applying it; the kind of crops grown; and the climate of the region. Because these factors are highly variable, every method of classifying waters for irrigation is somewhat arbitrary.

The most important characteristics in determining the quality of irrigation water, according to the U.S. Salinity Laboratory Staff (1954, p. 69) are: (1) total concentration of soluble salts, (2) relative proportion of sodium to other cations, (3) concentration of boron or other elements that may be toxic, and (4) the excess of equivalents of bicarbonate over equivalents of calcium plus magnesium.

High concentrations of dissolved salts in irrigation water may cause a buildup of salts in the soil solution, and may make the soil saline. The increased salinity of the soil may reduce crop yields by decreasing the ability of the plants to take up water and essential plant nutrients from the soil solution. The tendency of irrigation water to cause a buildup of salts in the soil is called the salinity hazard of the water. The specific conductance of the water is used as an index of the salinity hazard.

High concentrations of sodium (Na) relative to the concentrations of calcium (Ca) and magnesium (Mg) in irrigation water can adversely affect soil structure. Cations in the soil solution become fixed on the surface of the soil particles; calcium and magnesium tend to flocculate the particles, whereas sodium tends to deflocculate them. This adverse effect on soil structure caused by high sodium concentrations in an irrigation water is called the sodium hazard of the water. An index used for predicting the sodium hazard is the sodium-adsorption ratio (SAR), which is defined by the equation:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}},$$

where the concentrations of the ions are expressed in milliequivalents per liter.

The U.S. Salinity Laboratory Staff has prepared a classification for irrigation waters in terms of salinity and sodium hazard. Empirical equations were used in developing a diagram reproduced in modified form as Figure 5, which uses SAR and specific conductance in classifying irrigation waters. This classification, although embodying both research and field observations, should be used only as a general guide because many additional factors also affect the suitability of water for irrigation. With respect to salinity and sodium hazards, waters are divided into four classes; low, medium, high, and very high. The classification range encompasses waters that can be used for irrigation of most crops on most soils as well as waters that are usually unsuitable for irrigation. The salinity and sodium hazards of water at selected sites in the Red River basin are given on Figure 5.

Geographic Variations in Water Quality

Variations in dissolved solids, hardness, and chloride in the Red River basin are shown in Figures 12, 13, and 14. These values are based on the discharge-weighted average concentrations, as calculated from chemical-quality data. The discharge-weighted average represents the chemical character of the water if all the water passing a point in the stream during a period were impounded in a reservoir and mixed, with no adjustments for rainfall, evaporation, or chemical changes that might occur during storage. For many of the streams

Table 3.—Water-Quality Tolerances for Industrial Applications[1]

[Allowable Limits in Milligrams Per Liter Except as Indicated]

INDUSTRY	TUR-BID-ITY	COLOR	COLOR $+O_2$ CON-SUMED	DIS-SOLVED OXYGEN (ml/l)	ODOR	HARD-NESS	ALKA-LINITY (AS $CaCO_3$)	pH	TOTAL SOLIDS	Ca	Fe	Mn	Fe+ Mn	Al_2O_3	SiO_2	Cu	F	CO_3	HCO_3	OH	$CaSO_4$	Na_2SO_4 TO Na_2SO_3 RATIO	GEN-ERAL[2]
Air Conditioning[3]	--	--	--	--	--	--	--	--	--	--	0.5	0.5	0.5	--	--	--	--	--	--	--	--	--	A,B
Baking	10	10	--	--	--	(4)	--	--	--	--	.2	.2	.2	--	--	--	--	--	--	--	--	--	C
Boiler feed:																							
0-150 psi	20	80	100	2	--	75	--	8.0+	3,000-1,000	--	--	--	--	5	40	--	--	200	50	50	--	1 to 1	--
150-250 psi	10	40	50	.2	--	40	--	8.5+	2,500-500	--	--	--	--	.5	20	--	--	100	30	40	--	2 to 1	--
250 psi and up	5	5	10	0	--	8	--	9.0+	1,500-100	--	--	--	--	.05	5	--	--	40	5	30	--	3 to 1	--
Brewing:[5]																							
Light	10	--	--	--	Low	--	75	6.5-7.0	500	100-200	.1	.1	.1	--	--	--	1	--	--	--	100-200	--	C,D
Dark	10	--	--	--	Low	--	150	7.0→	1,000	200-500	.1	.1	.1	--	--	--	1	--	--	--	200-500	--	C,D
Canning:																							
Legumes	10	--	--	--	Low	25-75	--	--	--	--	.2	.2	.2	--	--	--	--	--	--	--	--	--	C
General	10	--	--	--	Low	--	--	--	--	--	.2	.2	.2	--	--	--	1	--	--	--	--	--	C
Carbonated beverages[6]	2	10	10	--	0	250	50	--	850	--	.2	.2	.3	--	--	--	.2	--	--	--	--	--	C
Confectionary	--	--	--	--	Low	--	--	(7)	100	--	.2	.2	.2	--	--	--	--	--	--	--	--	--	--
Cooling[8]	50	--	--	--	--	50	--	--	--	--	.5	.5	.5	--	--	--	--	--	--	--	--	--	A,B
Food, general	10	--	--	--	Low	--	--	--	--	--	.2	.2	.2	--	--	--	--	--	--	--	--	--	C
Ice (raw water)[9]	1-5	5	--	--	--	--	30-50	--	300	--	.2	.2	.2	--	10	--	--	--	--	--	--	--	C
Laundering	--	--	--	--	--	50	--	--	--	--	.2	.2	.2	--	--	--	--	--	--	--	--	--	--
Plastics, clear, undercolored	2	2	--	--	--	--	--	--	200	--	.02	.02	.02	--	--	--	--	--	--	--	--	--	--
Paper and pulp:[10]																							
Groundwood	50	20	--	--	--	180	--	--	--	--	1.0	.5	1.0	--	--	--	--	--	--	--	--	--	A
Kraft pulp	25	15	--	--	--	100	--	--	300	--	.2	.1	.2	--	--	--	--	--	--	--	--	--	--
Soda and sulfite	15	10	--	--	--	100	--	--	200	--	.1	.05	.1	--	--	--	--	--	--	--	--	--	--
Light paper, HL-Grade	5	5	--	--	--	50	--	--	200	--	.1	.05	.1	--	--	--	--	--	--	--	--	--	B
Rayon (viscose) pulp:																							
Production	5	5	--	--	--	8	50	--	100	--	.05	.03	.05	<8.0	<25	<5	--	--	--	--	--	--	--
Manufacture	.3	--	--	--	--	55	--	7.8-8.3	--	--	.0	.0	.0	--	--	--	--	--	--	--	--	--	--
Tanning[11]	20	10-100	--	--	--	50-135	135	8.0	--	--	.2	.2	.2	--	--	--	--	--	--	--	--	--	--
Textiles:																							
General	5	20	--	--	--	20	--	--	--	--	.25	.25	--	--	--	--	--	--	--	--	--	--	--
Dyeing[12]	5	5-20	--	--	--	20	--	--	--	--	.25	.25	.25	--	--	--	--	--	--	--	--	--	--
Wool scouring[13]	--	70	--	--	--	20	--	--	--	--	1.0	1.0	1.0	--	--	--	--	--	--	--	--	--	--
Cotton bandage[13]	5	5	--	--	Low	20	--	--	--	--	.2	.2	.2	--	--	--	--	--	--	--	--	--	--

1/ American Water Works Association, 1950.
2/ A—No corrosiveness; B—No slime formation; C—Conformance to Federal drinking water standards necessary; D-NaCl, 275 mg/l.
3/ Waters with algae and hydrogen sulfide odors are most unsuitable for air conditioning.
4/ Some hardness desirable.
5/ Water for distilling must meet the same general requirements as for brewing (gin and spirits mashing water of light-beer quality; whiskey mashing water of dark-beer quality).
6/ Clear, odorless, sterile water for syrup and carbonization. Water consistent in character. Most high quality filtered municipal water not satisfactory for beverages.
7/ Hard candy requires pH of 7.0 or greater, as low value favors inversion of sucrose, causing sticky product.
8/ Control of corrosiveness is necessary as is also control of organisms, such as sulfur and iron bacteria, which tend to form slimes.
9/ Ca $(HCO_3)_2$ particularly troublesome. $Mg(HCO_3)_2$ tends to greenish color. CO_2 assists to prevent cracking. Sulfates and chlorides of Ca, Mg, Na should each be less than 300 mg/l (white butts).
10/ Uniformity of composition and temperature desirable. Iron objectionable as cellulose adsorbs iron from dilute solutions. Manganese very objectionable, clogs pipelines and is oxidized to permanganates by chlorine, causing reddish color.
11/ Excessive iron, manganese, or turbidity creates spots and discoloration in tanning of hides and leather goods.
12/ Constant composition; residual alumina 0.5 mg/l.
13/ Calcium, magnesium, iron, manganese, suspended matter, and soluable organic matter may be objectionable.

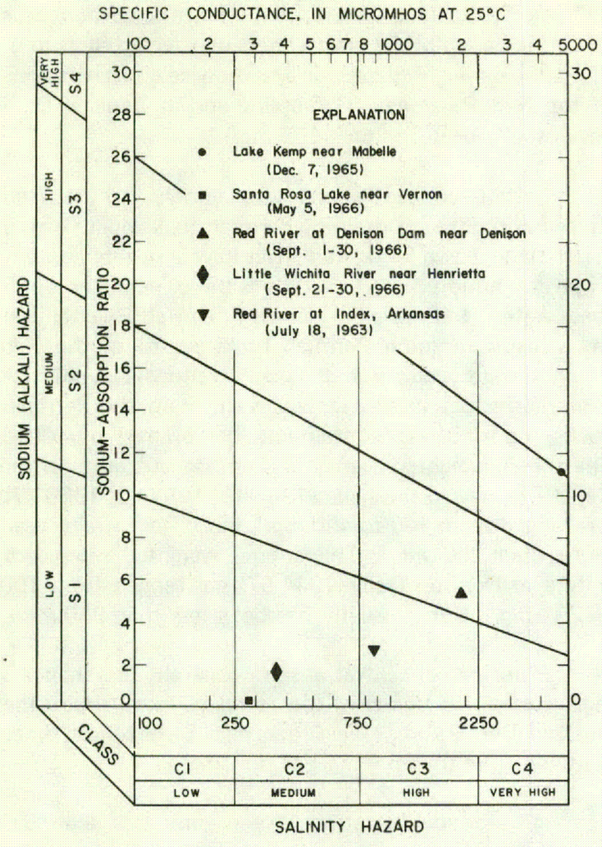


Figure 5.—Diagram for Classification of Irrigation Waters

chemical-quality data are limited, especially data on the chemical quality of flood flows; therefore, the subdivisions shown on the maps should be considered as generalized. All the streams will at times have concentrations exceeding those shown, but the averages are indicative of the quality of water that would be stored in a hypothetical reservoir.

Dissolved Solids

The concentrations of dissolved solids in streams in the Red River basin range from several thousand to less than 250 mg/l (milligrams per liter) (Figure 3). Water from the outcrop areas of Tertiary age in the extreme western part of the basin usually have dissolved-solids concentrations less than 250 mg/l. Downstream from the Tertiary outcrop, rocks of Triassic and Permian age contribute water containing very high concentrations of dissolved solids; more than 10,000 mg/l is common in some areas. The highly concentrated water from the Prairie Dog Town, Salt, and North Forks Red River, Pease River, and North and South Wichita Rivers cause the mainstem Red River to contain more than 1,000 mg/l of dissolved solids throughout most of its reach in Texas. About midway between Lake Texoma and Index, Arkansas, good quality inflow from the tributaries is of sufficient quantity to cause the Red River to contain less than 1,000 mg/l of dissolved solids.

The discharge-weighted average concentrations of dissolved solids of the Red River near Gainesville for the periods 1944-46, 1953-63, and 1966-67 has ranged from a minimum of 891 mg/l in 1945 to a maximum of 1,950 mg/l in 1958. The discharge-weighted average concentration of dissolved solids of the Red River at Denison Dam for the period 1944-1967 has ranged from 486 mg/l in 1946 to 1,230 mg/l in 1961. The discharge-weighted average concentrations of dissolved solids at Index, Arkansas for 1961, 1962, and 1963 were 728 mg/l, 609 mg/l, and 538 mg/l, respectively. The analyses showing annual maximum and minimum dissolved-solids concentrations and the weighted averages for the stations are given in Table 5. Annual dissolved-solids averages for Red River at Denison Dam are shown on Figure 7.

Time-weighted averages represented by duration curves are usually higher than discharge-weighted averages. The duration curve for dissolved-solids concentrations for the Red River near Gainesville during 1953-62 is shown in Figure 6. Dissolved solids equaled or exceeded 3,560 mg/l 10 percent of the time, 3,040 mg/l 30 percent of the time, 2,620 mg/l 50 percent of the time, and 1,100 mg/l 90 percent of the time.

Downstream from the Wichita River, Texas tributaries drain Cretaceous rocks and contribute water containing less than 250 mg/l of dissolved solids. The discharge-weighted average concentration of dissolved solids of the Little Wichita River near Henrietta for the periods 1953-55 and 1959-66 ranged from 124 to 286 mg/l and averaged 211 mg/l; and the Little Wichita River near Ringgold for the 1959-62 period ranged from 151 to 187 mg/l and averaged 171 mg/l.

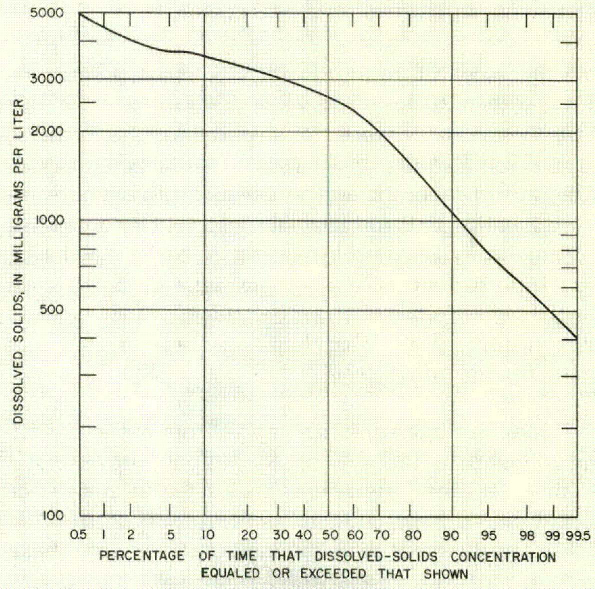


Figure 6.—Duration Curve of Dissolved Solids for Red River Near Gainesville, Texas, 1953-63

Chloride

The concentrations of chloride in surface water of the Red River basin vary from several thousand to less than 100 mg/l. Concentrations are generally less than 250 mg/l in all streams not affected by natural or oil-field brines. Brines in the drainage areas of the Prairie Dog Town, Salt, and North Forks Red River, Pease River, and North and South Wichita Rivers degrade the quality of the Red River throughout its reach in Texas. The annual weighted-average chloride concentration of the Red River near Gainesville (1944-46, 1953-63, 1966-67) has ranged from 283 to 717 mg/l, and at Denison Dam (1944-67), it has ranged from 139 to 431 mg/l. Chloride concentration of the main stem is generally more than 500 mg/l almost as far downstream as Lake Texoma, but it is less than 250 mg/l through the last 100-150 miles of its reach in Texas. Tributaries downstream from the Wichita River generally have chloride concentrations less than 50 mg/l.

Hardness

Surface water in the Red River basin generally ranges from moderately hard (61-120 mg/l) to very hard (more than 180 mg/l). Waters of streams in the western and central parts of the basin that contain high concentrations of dissolved solids are very hard, often having more than 500 mg/l hardness. The streams draining Cretaceous rocks in the eastern part of the basin generally contain waters that are moderately hard, even though they usually have a low dissolved-solids content.

Other Constituents

Other constituents of importance in the evaluation of the chemical quality of a water include silica, sodium, bicarbonate, sulfate, fluoride, and nitrate.

Silica concentrations in the Red River basin range from less than 10 to nearly 70 mg/l. In the western part of the basin, water from streams draining the Tertiary, Triassic, and Permian rocks usually contains more than 20 mg/l of silica. In the central part of the basin, streams draining rocks of Pennsylvanian age usually contain 10 to 15 mg/l of silica; and in the eastern part of the basin, water from rocks of Cretaceous age usually contains less than 10 mg/l of silica. The annual weighted-average silica concentration of the Red River at Denison Dam has usually been about 10 mg/l.

Sodium concentrations range from several thousand to less than 100 mg/l. Concentrations are generally less than 100 mg/l in streams unaffected by natural or oil-field brines. The sodium concentration of the Red River is usually more than 250 mg/l upstream from Lake Texoma and 100 to 250 mg/l from Lake Texoma to Index, Arkansas.

Bicarbonate concentrations are usually less than 250 mg/l in surface waters in the basin; bicarbonate is the principal anion in most waters unaffected by brines. The annual weighted-average bicarbonate concentrations of the Red River near Gainesville and at Denison Dam have usually been less than 150 mg/l.

Sulfate concentrations vary widely in the Red River basin. Streams draining Permian rocks north of the Priarie Dog Town Fork Red River have a sulfate content of several hundred mg/l. Sulfate is the principal anion in these waters. In Prairie Dog Town Fork Red River and in the streams draining Permian rocks south of the Red River, sulfate occurs in high concentrations; but chloride is the principal anion. Downstream from the Permian rocks, the tributaries contain less than 50 mg/l of sulfate. The annual weighted-average sulfate concentration of the Red River near Gainesville (1944-46, 1953-63, 1966-67) has ranged from 169 to 450 mg/l, but it has usually been more than 250 mg/l. The annual weighted-average of sulfate at Denison Dam (1944-67) has ranged from 100 to 297 mg/l, but it usually has been less than 250 mg/l.

Fluoride concentrations are generally less than 1.0 mg/l except in some of the streams that drain the Ogallala Formation. Tule Creek near Silverton at times contains more than 5.0 mg/l of fluoride.

Nitrate concentrations are usually less than 5.0 mg/l, except in some of the heavily irrigated areas of the High Plains where concentrations sometimes exceed 10 mg/l.

Water Quality in Reservoirs

Chemical analyses for most of the principal reservoirs in the Texas part of the Red River basin are given in Table 6. Most of the reservoirs are on tributaries where quality-of-water problems are less severe than on the main stem.

Buffalo Lake

When sampled in 1951, water in Buffalo Lake contained 472 mg/l dissolved solids, 27 mg/l of chloride and was very hard. Principal chemical constituents were sodium and bicarbonate.

Bivins Lake

Chemical analyses are not available for Bivins Lake, but analyses for downstream sites indicate that the stored water contains less than 500 mg/l of dissolved solids, is hard, and has calcium, sodium, bicarbonate, and sulfate as the principal chemical constituents.

Baylor Creek Reservoir

Very limited data indicate that Baylor Creek Reservoir impounds water containing between 500 and 1,000 mg/l of dissolved solids. The water is very hard and of a calcium sulfate type.

Greenbelt Reservoir

Greenbelt Reservoir was not impounding water during this study, but the chemical quality of its water can be inferred from analyses of Salt Fork Red River near Clarendon. Analyses of samples collected during low flow indicate that the dissolved-solids content seldom exceeds 500 mg/l. No data are available on the quality of water at high flow, but it is likely that the dissolved-solids content would be less than at low flow. Therefore, water impounded in the reservoir probably will contain less than 500 mg/l of dissolved solids, be very hard, and of a mixed chemical type.

Lake Kemp and Diversion Lake

Lake Kemp and Diversion Lake were constructed in 1923 and 1924, respectively, and are two of the oldest major reservoirs in the Red River basin. Water is released from Lake Kemp into Diversion Lake and then released or withdrawn for industrial use and irrigation. The reservoirs are downstream from natural salt-contributing areas. Sources of natural pollution of the Wichita River above Lake Kemp were investigated by Joerns (1961) and by the U.S. Public Health Service (1964). Chemical analyses indicate that since construction the impounded water has usually contained 2,000 to 3,000 mg/l dissolved solids. Calcium, sodium, sulfate, and chloride are the principal dissolved constituents. The water is suitable for irrigation for only highly salt-tolerant crops.

Santa Rosa Lake

Water stored in Santa Rosa Lake is low in dissolved solids, moderately hard, and of a calcium bicarbonate type.

North Fork Buffalo Creek Reservoir

Chemical analyses are not available for North Fork Buffalo Creek Reservoir, but analyses for North Fork Buffalo Creek near Iowa Park indicate that at high flow the water is of good quality; dissolved-solids content is less than 200 mg/l. Analyses of water at low flow, however, indicate oil-field brine pollution. The quality of the stored water will depend upon the extent to which brine reaches North Fork Buffalo Creek upstream from the reservoir.

Lake Wichita

Natural runoff into Lake Wichita is probably of good quality. However, the lake receives return flow from areas irrigated with water from Lake Kemp, and also is degraded with water from oil fields. The dissolved-solids content usually exceeds 1,000 mg/l. An analysis in June 1965 showed that the water in Lake Wichita contained 1,450 mg/l of dissolved solids; calcium, sodium, sulfate, and chloride are the principal chemical constituents.

Lake Kickapoo

Water stored in Lake Kickapoo usually contains less than 250 mg/l of dissolved solids and is moderately hard. Principal dissolved constituents are calcium, sodium, and bicarbonate.

Lake Arrowhead

Impoundment of water in Lake Arrowhead began in 1966, and no analyses of the stored water were available during the study period. The quality of the stored water can, however, be inferred from records for the daily sampling station, Little Wichita River near Henrietta. During the period of daily record (1952-55, 1959-66), the annual weighted-average dissolved-solids concentration has ranged from 124 to 286 mg/l, and averaged 218 mg/l. The water was of a sodium chloride type—probably because of oil-field brine reaching the stream.

Farmers Creek Lake

When sampled in 1967, water in Farmers Creek Lake contained 294 mg/l of dissolved solids and was hard. Principal chemical constituents were calcium, sodium, bicarbonate, and chloride.

Hubert H. Moss Lake

Chemical-quality data are not available for Hubert H. Moss Lake, but records from adjoining watersheds in the Trinity River basin indicate that the reservoir, when filled, will contain moderately hard water having a low dissolved-solids content.

Lake Texoma

Denison Dam which forms Lake Texoma was built in 1942 by the U.S. Army Corps of Engineers for flood control and hydroelectric power. Increasing needs for water have caused Lake Texoma to be considered as a source of water for public supply even though it has generally been too highly mineralized for this use. Water from Lake Texoma is pumped to Lake Randall to augment the municipal supply for the city of Denison. The city of Sherman has studied the practicability of damming off the Big Mineral Arm of the lake to obtain a municipal supply (Mendieta and Skinner, 1966).

Since 1965, the dissolved-solids content of water in Lake Texoma has ranged from 969 to 1,230 mg/l. Chloride has ranged from 325 to 442 mg/l, and sulfate from 228 to 296 mg/l. Although the dissolved-solids content of Lake Texoma water varies from year to year, 23 years of records collected since impoundment began in 1944 show a definite trend of increasing mineralization. Annual weighted-average concentrations of dissolved solids for the outflow station at Denison Dam are shown on Figure 7. The net quantity of water available annually at Denison Dam (expressed as annual outflow plus change in storage, in thousands of acre-feet) is also shown on Figure 7. The net annual water available also represents the inflow to Lake Texoma minus losses due to evaporation, infiltration, and diversion. Along with the trend of increasing mineralization in Lake Texoma, Figure 7 shows a general trend toward less available water.

The mineralization of water of Lake Texoma is increasing because of (1) a continuous salt load reaching the reservoir from upstream natural and man-made brine sources, (2) decreasing inflows to the reservoir because of upstream impoundments, (3) increasing dissolved-solids concentrations of inflows because of upstream impoundments of good-quality water, and (4) increasing dissolved-solids concentrations because of evaporation from Lake Texoma and from impoundments upstream.

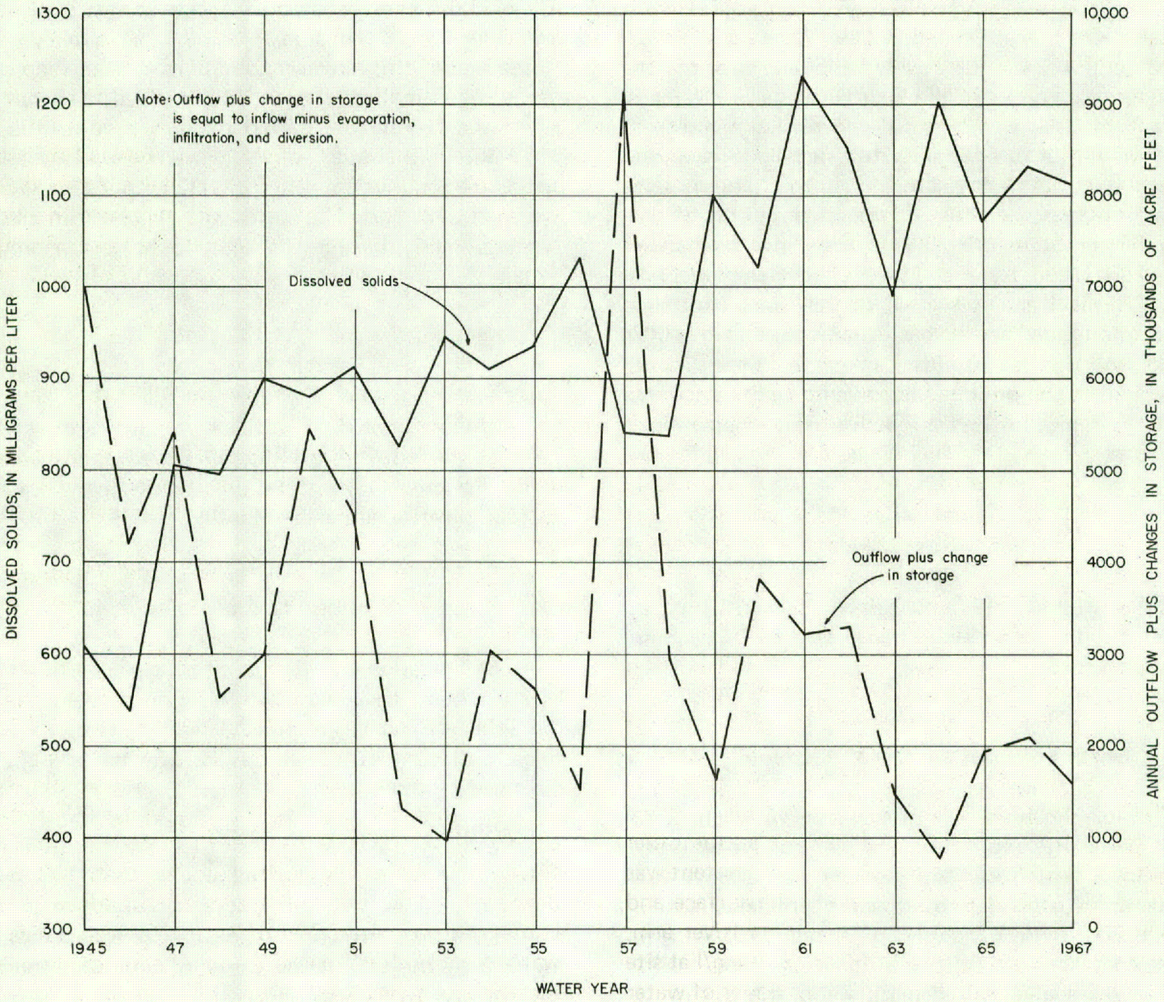


Figure 7.—Graph Showing Dissolved-Solids Content and Quantity of Water in Lake Texoma, 1945-67

Kane (1967, p. 17) shows average annual net lake-surface evaporation for Lake Texoma during the 1940-65 period to be 30 inches per year. At elevation 617 feet (top of power pool), Lake Texoma covers 89,000 acres. Therefore, evaporation losses from Lake Texoma may be more than 200,000 acre-feet per year. West of Lake Texoma average net annual evaporation losses increase rapidly to more than 50 inches in the High Plains. Waters that are released from impoundments above Lake Texoma after having been degraded by evaporation, further degrade the quality of inflows to the reservoir.

To aid in the evaluation of water quality in Lake Texoma, the Geological Survey made two reconnaissance-type surveys of the reservoir. The surveys were made in March and July 1967 to obtain data for different seasons of the year. Measurements of specific conductance, temperature, and dissolved oxygen were made at sites throughout the reservoir and at various depths at each site. Water samples were collected at selected sites for laboratory analysis. Figure 8 is a map of the reservoir showing the observation sites.

The first survey was made March 21-23. During this period, surface elevation remained almost constant at approximately 603 feet above mean sea level (contents, 1,710,000 acre-feet), and water was being released through the powerhouse. The reservoir was well mixed during this survey. Dissolved-solids content, estimated from specific conductance values and verified by laboratory analyses (dissolved solids equals approximately 0.58 specific conductance), increased only slightly with depth at each site. In the Red River arm, dissolved-solids content was nearly uniform at about 1,200 mg/l from site 1C to site 24C, but increased upstream to about 1,700 mg/l at site 38C. In the Washita River arm, concentrations decreased in an upstream direction to about 1,000 mg/l at site 12C. Temperatures generally were about 1°C lower at the bottom of the lake than at the surface. Dissolved oxygen was nearly uniform throughout the vertical profile at each site—near saturation at the surface and only about 1 mg/l less near the bottom. Vertical profiles for sites 1C and 3C are shown on Figure 9.

During the second survey, made July 25-27, surface elevation was about 614 feet (contents, 2,480,000 acre-feet, an increase of 770,000 acre-feet since the March survey). The dissolved-solids content varied only slightly with depth at each site except at site 38C where the concentration was 1,090 mg/l at the surface and 2,290 mg/l at the bottom. At all the other sites on the Red River arm, dissolved-solids content was near 1,000 mg/l, usually slightly less at the surface and slightly more at the bottom. In the Washita River arm, the dissolved-solids content varied from 935 mg/l at site 7C to about 700 mg/l at site 12C. A thin layer of water about 40 feet below the surface was less concentrated than the water above and below. Temperature and oxygen stratification was evident in all areas of the reservoir. At site 1C, temperature decreased from 25.8°C at the surface to 21.4°C at the bottom, and dissolved oxygen decreased from 7.2 mg/l at the surface to 0.0 mg/l at the bottom. At most sites, temperature and oxygen decreased slightly with depth through the top 50 feet, then decreased sharply through the next 10 feet, and was nearly uniform through the remaining depth. Vertical profiles for sites 1C and 3C are shown on Figure 9, and longitudinal profiles for the Red River and Washita River arms during the July 25-27 period are shown on Figure 10.

Lake Texoma, like many reservoirs in the southwest, undergoes thermal stratification in the summer and becomes almost completely mixed during the winter. During the summer, the more concentrated inflow from the Red River tends to flow along the bottom of the reservoir and the less concentrated inflow from the Washita River tends to seek an intermediate depth. Dissolved-solids content of the reservoir increases upstream in the Red River arm and decreases upstream in the Washita River arm. During the winter, oxygen is available at all depths throughout the reservoir, but during the summer is generally deficient at all depths greater than 50 feet.

Lake Randall

Lake Randall, a small reservoir owned by the city of Denison, is used as a municipal supply. Water is pumped from Lake Texoma to augment the normal yield, and quality of the water in Lake Randall is therefore determined by the proportion of water that is pumped from Lake Texoma.

Brushy Creek Reservoir and Coffee Mill Creek Lake

Although no chemical analyses are available for either of these reservoirs, the water quality can be inferred from records for nearby Bois d'Arc Creek and from records for watersheds in the adjacent Trinity River basin. Water in these areas is usually hard and of a calcium bicarbonate type. The dissolved-solids content averages less than 250 mg/l.

Pat Mayse Reservoir

Pat Mayse Reservoir was not impounding water during this study, but its quality can be inferred from analyses of Sanders Creek near Chicota (site 104). High flows in Sanders Creek contained less than 100 mg/l of dissolved solids, and the reservoir should store water containing less than 200 mg/l of dissolved solids. The water will be moderately hard and of a calcium bicarbonate type.

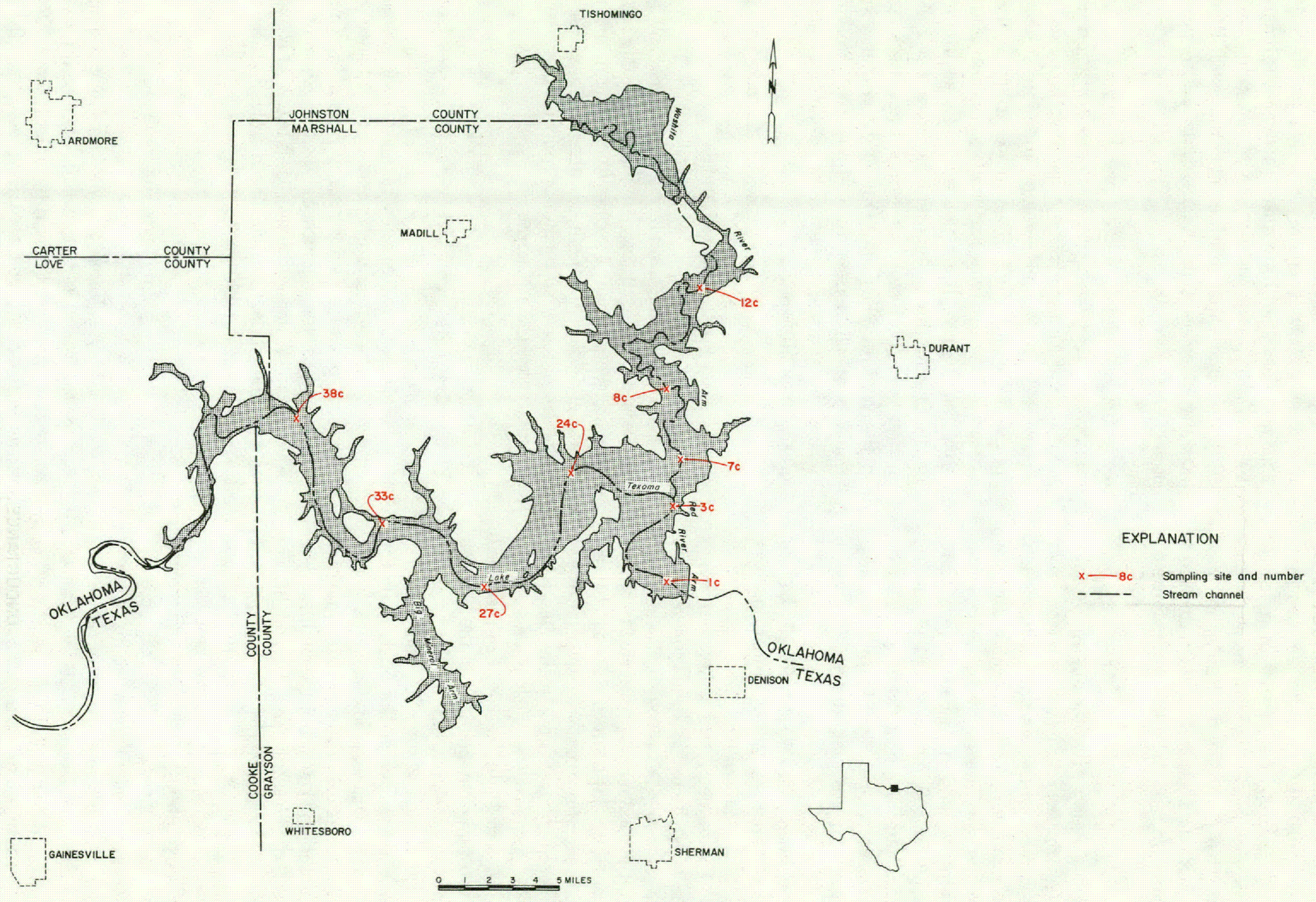


Figure 8

Sampling Sites in Lake Texoma

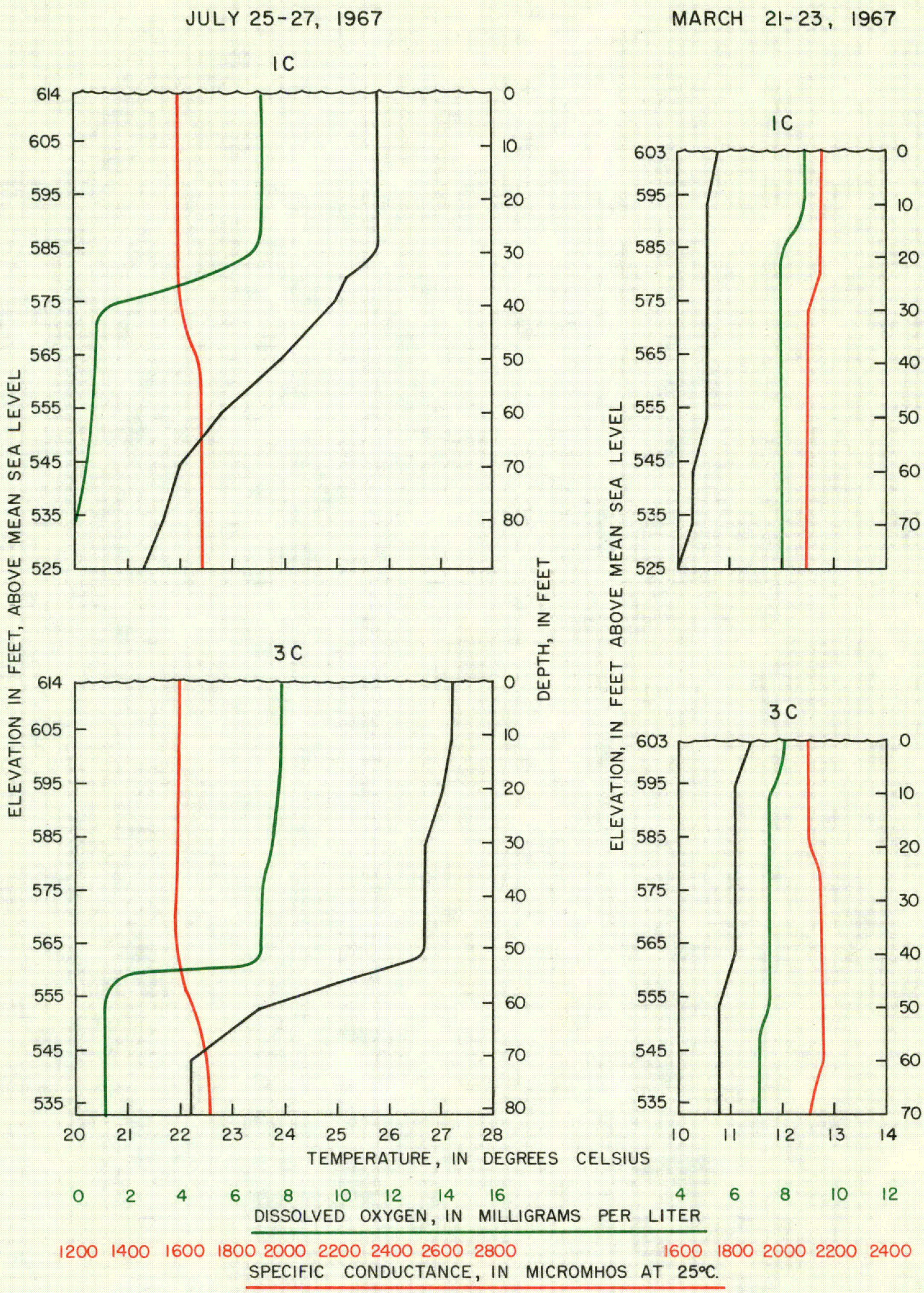
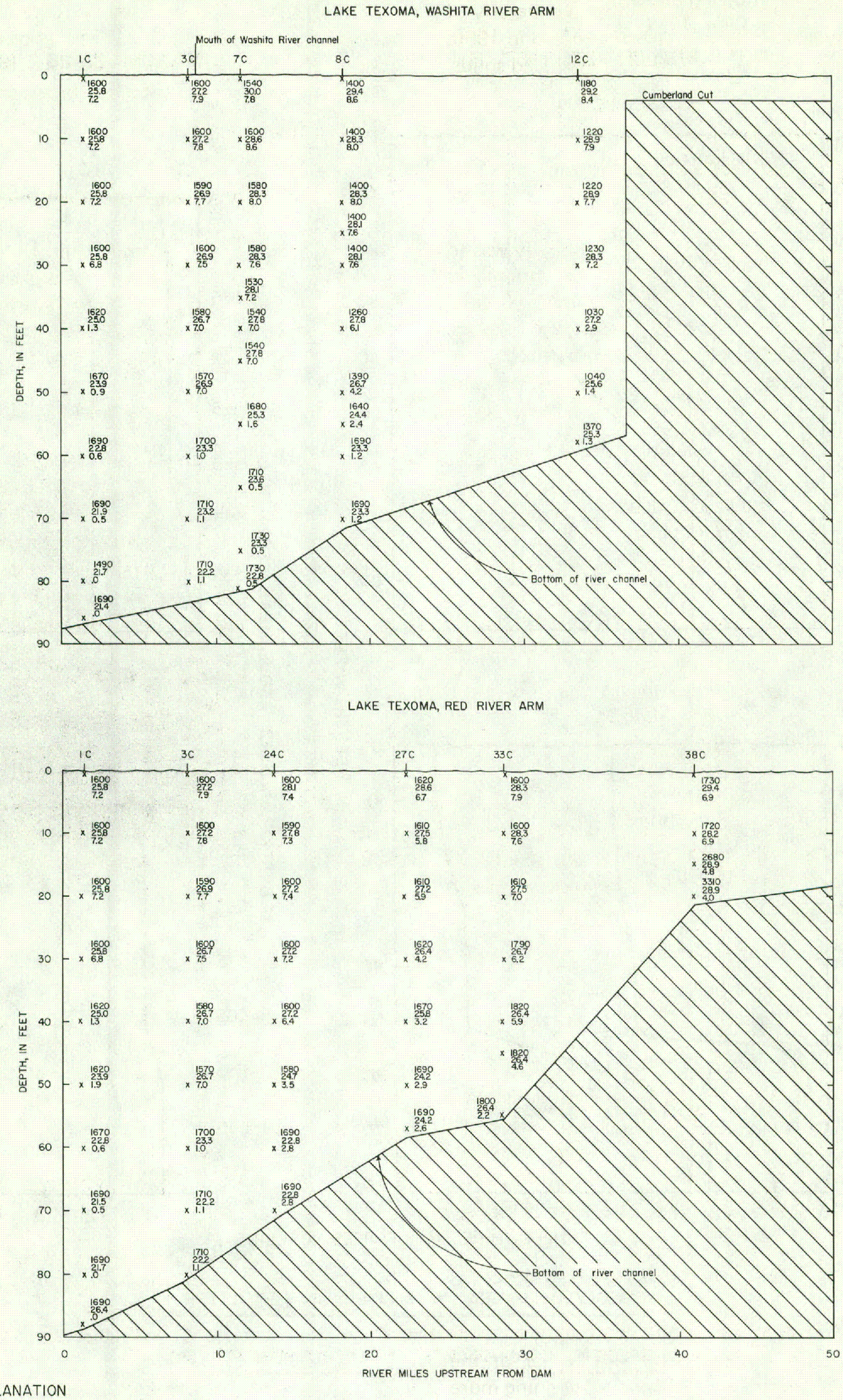


Figure 9

Vertical Profiles of Specific Conductance, Dissolved Oxygen, and Temperature of Lake Texoma



EXPLANATION

1600	Specific conductance, in micromhos at 25° C.
25.8	Temperature, in degrees Celsius
7.2	Dissolved oxygen, in milligrams per liter
3C x	Sampling site

Figure 10

Longitudinal Profiles of Lake Texoma Showing Water Quality, July 25-27, 1967

Lake Crook

Lake Crook is owned and operated by the city of Paris for municipal water supply. When sampled in 1960, the reservoir water contained 70 mg/l of dissolved solids, was soft, and of a calcium bicarbonate type.

Water Quality at Potential Reservoir Sites

One of the principal objectives of this study was to appraise the quality of water available for storage at potential reservoir sites in the Red River basin. Several potential sites suggested by various agencies are shown on Figure 11. In the following discussion, evaluations of water quality are based on 1967 conditions and the names of potential reservoir sites are those in use as of December 31, 1967.

Mackenzie

A reservoir on Tule Creek at the Mackenzie site would impound water of good quality; the dissolved-solids content would be less than 250 mg/l. The water would be hard and have calcium and bicarbonate as its principal ions.

Buck Creek

Information is not available on the chemical quality of flood flow in Buck Creek. Low-flow samples show high concentrations of calcium and sulfate. A reservoir on Buck Creek would probably impound water containing more than 1,000 mg/l of dissolved solids.

Lelia Lake Creek

Although water samples have been collected periodically for several years, data on the chemical quality of flood flows in Lelia Lake Creek is lacking. Available data indicate that a reservoir on Lelia Lake Creek would impound water of mixed chemical composition containing about 500 mg/l dissolved solids. The water would undoubtedly contain more than 500 mg/l of dissolved solids at times.

Dozier Creek

A reservoir on the Salt Fork Red River at the Dozier site would probably store water containing more than 1,000 mg/l of dissolved solids. A 2-year (1953-54) daily record is available for a station near Wellington (site 47). The weighted-average dissolved-solids concentrations were 1,300 mg/l in 1953 and 1,100 mg/l in 1954.

Lower McClellan Creek

Limited chemical-quality data indicate that a reservoir on McClellan Creek would store water containing about 500 mg/l dissolved solids. The water would be of a mixed chemical type and would be very hard.

Sweetwater Creek

A reservoir on Sweetwater Creek would store water of acceptable quality for most uses. The water would be of a calcium sodium bicarbonate type and contain less than 500 mg/l dissolved solids.

Ringgold

Daily chemical-quality records for the Little Wichita River near Henrietta and Ringgold indicate that a reservoir near the Ringgold site would impound water of good quality. At the Henrietta station the annual weighted-average concentration of dissolved solids was less than 300 mg/l each year during the period of record (1953-66). Oil-field brine has reached the streams in the watershed, and has caused some deterioration of the otherwise excellent-quality water.

Timber Creek and Bois d'Arc Creek

The water available for storage at these sites is of a calcium and sodium bicarbonate type and is moderately hard. The dissolved-solids content should be less than 250 mg/l.

Big Pine

A reservoir on Big Pine Creek would impound water containing less than 150 mg/l dissolved solids. The water would be low in all dissolved constituents and would be soft.

Pecan Bayou

The water in Pecan Bayou is always low in dissolved constituents, therefore, water impounded at the Pecan Bayou site would contain less than 100 mg/l dissolved solids and would be soft.

Barkman Creek

A reservoir on Barkman Creek would impound water containing less than 100 mg/l dissolved solids. The water would be soft and low in all dissolved constituents.

Present and Future Water-Quality Problems

Natural and in the past, oil-field brines are the principal degrading influences on water-quality of the Red River. The highly mineralized waters from salt sources in the western part of the basin cause the water of the Red River to be undesirable for public supply throughout most of its reach in Texas. The salinity problems in the Red River basin have been intensively studied by various Federal agencies. The U.S. Public Health Service (1964) reported that there are 10 primary natural brine emission areas in the Red River basin. Figure 4 shows the locations of the primary sources and several secondary sources, and includes the average daily salt load that the Public Health Service calculated to be contributed by each primary source. A detailed description of each source is given in the report by the Public Health Service (1964).

The U.S. Army Corps of Engineer District at Tulsa, Oklahoma, has prepared a report (1966) on the feasibility of plans to control the major salt sources in the Arkansas and Red River basins and has constructed an experimental control project at Estelline Springs on Prairie Dog Town Fork Red River. Congress has authorized construction of additional salt-control projects on three tributaries of the Wichita River above Lake Kemp, and the Corps of Engineers has proposed five additional projects in the Red River basin, four in Texas and one in Oklahoma.

The plan for control of salt in the Wichita River consists of three low-water dams, pumping facilities, and pipelines for collecting highly mineralized water and moving it to storage basins for evaporation. The Corps estimates that the chloride load reaching Lake Kemp would be reduced by about 80 percent and the sulfate load by about 30 percent. Chloride concentrations would rarely exceed 200 mg/l and sulfate would usually be less than 500 mg/l.

Maximum control of both man-made and natural brine pollution throughout the upper Red River basin, as proposed by the Corps of Engineers, would greatly improve the quality of the water impounded in Lake Texoma. The Corps estimates that chloride concentrations would be less than 110 mg/l 50 percent of the time, and would seldom exceed 150 mg/l. Dissolved solids would be reduced to an average of about 820 mg/l and sulfate to about 220 mg/l. With its quality thus improved, water of the lower Red River will be suitable for a wider variety of beneficial uses.

Impoundments on tributaries in Texas and Oklahoma and in Lake Texoma are also causing degradation of water quality in the main stem. Of the 18 existing reservoirs on tributary streams in Texas, 16 are impounding water of better quality than is carried by the Red River. Of the 11 potential reservoir sites discussed, 9 would impound water having better quality than water of the main stem.

The city of Sherman is considering damming off Big Mineral Arm of Lake Texoma which is less mineralized than the main body of the reservoir. Most existing and any future reservoirs on Oklahoma tributaries will impound waters of better quality than is carried by the mainstem Red River. Removal of the water of tributary streams leaves water of poorer quality in the Red River. Surface impoundments in the Red River basin will further degrade water of the basin because of evaporation losses. Figure 7 shows the trend of increasing mineralization of Lake Texoma waters, which must result in part from evaporation losses. According to Kane (1967, p. 17) average annual net lake surface evaporation rates vary from 10 inches near the Texas-Arkansas line to more than 50 inches in the High Plains.

The population of the Red River basin in Texas has doubled in the past 25 years. The population growth is expected to be greater in the next 25 years. Along with increasing demands for municipal supplies, more water will be needed for industry and irrigation. If a significant part of these supplies is to come from surface waters of the Red River basin, a maximum effort to improve water quality will be required.

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WATER YEAR	U.S.G.S. WATER-SUPPLY PAPER NO.	T.W.D.B. REPORT NO.	OKLAHOMA WATER RESOURCES BOARD REPORT
1940-45	–	*1938-45	–
1946	1050	*1946	+1946-49
1947	1102	*1947	+1946-49
1948	1133	*1948	+1946-49
1949	1163	*1949	+1946-49
1950	1188	*1950	+1950
1951	1199	*1951	+1951
1952	1252	*1952	+1952
1953	1292	*1953	+1953
1954	1352	*1954	+1954
1955	1402	*1955	+1955
1956	1452	Bull. 5905	+1956
1957	1522	Bull. 5915	+1957
1958	1573	Bull. 6104	+1958
1959	1644	Bull. 6205	+1959
1960	1744	Bull. 6215	+1960
1961	1884	Bull. 6304	+1961
1962	1944	Bull. 6501	+1962
1963	1950	Rept. 7	+1963
1964	–	#	#
1965	–	#	#
1966	–	#	#

* "Chemical Composition of Texas Surface Waters" was designated only by water year from 1938 through 1955.

\+ "Chemical Character of Surface Water of Oklahoma" was designated only by water year from 1946 through 1963.

\# Published as U.S. Geological Survey open-file report.

Table 4.--Index of Surface-Water Records for the Red River Basin, Texas

Reference no.	Stream and location	Drainage area (sq. miles)	Type and period of record: Daily chemical quality	Discharge	Periodic chemical quality	Periodic discharge measurements	Reservoir content	Water temperature
1	Tierra Blanca Creek above Buffalo Lake near Umbarger	2075		1938-54, 1966				1949-54, 1966
2	Buffalo Lake near Umbarger	2075			1951		1938-54, 1966	
3	Tierra Blanca Creek below Buffalo Lake near Umbarger	--		1966				1966
4	Palo Duro Creek near Canyon	982		1942-54				1949-54
5	Prairie Dog Town Fork Red River near Canyon	3369		1937-49				
6	Prairie Dog Town Fork Red River above Stockton Dam near Canyon	--		1965		1961-65		1961-65
7	Lake Stockton near Canyon	--			1965-66			
8	Prairie Dog Town Fork Red River below Stockton Dam near Canyon	--				1961-65		1961-65
9	Prairie Dog Town Fork Red River above Palo Duro Park near Canyon	--			1961	1961-65		1961-65
10	Prairie Dog Town Fork Red River below Palo Duro Park near Canyon	--			1950, 1961, 1964-65	1961-65		1961-65
11	North Tule Draw at Reservoir near Tulia	189		1938-66			1938-66	1949-66
12	Tule Creek near Silverton	1150		1964-66	1964-66			1964-66
13	Prairie Dog Town Fork Red River near Brice	5972	1950-51	1938-44, 1949-51, 1959-62				1949-51, 1959-62
14	Mulberry Creek near Brice	534	1950-51	1949-51				1949-51
15	Prairie Dog Town Fork Red River near Lakeview *478	6792		1963-66				1963-66
16	Little Red River at State Highway 70 near Turkey	--			1959			
17	Prairie Dog Town Fork Red River near Estelline	7293		1937-47	1949-50			
18	Estelline Spring near Estelline	--			1959, 1962	1959, 1962		
19	Baylor Creek Reservoir near Childress	--			1949-50			
20	Baylor Creek near Childress	--			1948			
21	Salt Creek 12 miles northwest of Childress	--			1959			
22	Prairie Dog Town Fork Red River near Childress	7725		1964-66	1948-49, 1963			1964-66
23	Buck Creek near Wellington	210			1945, 1947-48 1951-53, 1955-56 1959, 1962	1950-64		1950-64
24	Red River near Quanah *750	8321		1959-66	1959			1959-66
25	North Groesbeck Creek near North Groesbeck	150			1951-53 1957-58, 1961	1951-64		1951-64
26	South Groesbeck Creek near Goodlett	--			1962	1962-64		1962-64
27	South Groesbeck Creek near Acme	146			1951-53 1957-58, 1961	1951-64		1951-64
28	Groesbeck Creek at State Highway 283 near Quanah	303		1962-66	1950-53, 1957-58 1960, 1965-66			1962-66

See footnote at end of table.

Table 4.--Index of Surface-Water Records for the Red River Basin, Texas--Continued

Reference no.	Stream and location	Drainage area (sq. miles)	Type and period of record					
			Daily chemical quality	Discharge	Periodic chemical quality	Periodic discharge measurements	Reservoir content	Water temperature
29	Wanderers Creek at Odell	199			1950-53 1957-58, 1960	1949-66		1949-66
30	Carroll Creek near Clarendon	--			1951-53	1948-60		1949-60
31	Kelly Creek near Clarendon	--				1961-65		1961-65
32	Greenbelt Reservoir near Clarendon						1966	
33	Salt Fork Red River near Clarendon	457			1950-53 1956, 1960, 1962	1950-60		1950-64
34	Salt Fork Red River above Saddlers Creek north of Lelia Lake	--			1951			
35	Barton Creek northeast of Clarendon	--			1959			
36	Saddlers Creek 8 miles northeast of Clarendon	--			1951			
37	Salt Fork Red River north of Lelia Lake	--			1951, 1959			
38	Lelia Lake Creek below Bell Creek near Hedley	74				1964-66		1964-66
39	Lelia Lake Creek near Hedley	79			1950-53 1957-58, 1964	1951-66		1951-66
40	Salt Fork Red River near Hedley	744	1957-61			1951, 1956-62		1951, 1956-62
41	Whitefish Creek near Alanreed	--			1962			
42	Whitefish Creek south of McLean	--			1951, 1962			
43	Whitefish Creek northeast of Hedley	--			1951, 1962			
44	Gyp Creek north of McKnight	--			1951			
45	Salt Fork Red River north of Quail	--			1959, 1963			
46	Dozier Creek near Wellington	--			1950-51, 1953 1955, 1960	1950-60		1950-60
47	Salt Fork Red River near Wellington *703	1222	1952-54	1962-66				1962-66
48	North Fork Red River west of Kellerville	--			1959			
49	McClellan Creek at State Highway 70 near Boydston	--			1950			
50	Lake McClellan near Jericho	--			1951			
51	McClellan Creek at State Highway 273 near McLean	--			1965	1965		
52	North Fork Red River near Shamrock	1082		1964-66	1951-53 1958-59, 1964-66	1951-63		1951-66
53	Sweetwater Creek at State Highway 152 west of Mobeetie	--			1951			
54	Sweetwater Creek at State Highway 152 southeast of Mobeetie	--			1951			
55	Sweetwater Creek near Wheeler	164			1951-53 1955, 1957-58	1951-64		1951-64
56	Sweetwater Creek near Kelton	287		1961-66	1962-66			1961-66
57	Elm Creek near Shamrock	--			1946-47, 1950-53 1955, 1958-59 1962	1947-65		1947-65
58	Elm Creek above Wolf Creek near Lutie	--			1962			

See footnote at end of table.

Table 4.--Index of Surface-Water Records for the Red River Basin, Texas--Continued

Reference no.	Stream and location	Drainage area (sq. miles)	Type and period of record: Daily chemical quality	Discharge	Periodic chemical quality	Periodic discharge measurements	Reservoir content	Water temperature
59	Wolf Creek at mouth near Lutie	--			1962			
60	Elm Creek below Wolf Creek near Lutie	--			1959, 1962			
61	Quitaque Creek near Quitaque	293		1945-59	1945-46, 1950-51	1960-66		1960-66
62	Roaring Springs near Roaring Springs	--			1937, 1952-56 1958-60, 1962	1937, 1943-66		1949-66
63	Middle Pease River near Paducah	--			1950, 1959			
64	Salt Springs tributary to Middle Pease River 14 miles northeast of Paducah	--			1959			
65	Pease River near Childress *755	2747		1959-62	1959			1959-62
66	Pease River near Crowell	3037	1942-43	1924-47				
67	Pease River near Vernon *759	3488		1959-66	1942, 1951			1959-66
68	Red River near Burkburnett	20570		1959-66	1959	1924-25		1959-66
69	North Wichita River 11 miles south of Paducah	--			1951-54			
70	North Wichita River 10 miles southeast of Paducah	--			1951-54			
71	Salt Creek 4 miles southeast of Paducah	--			1951-52, 1958			
72	Salt Creek at mouth 8 miles southeast of Paducah	--			1939, 1951-54, 1956, 1958-59			
73	North Wichita River below Salt Creek 12 miles southeast of Paducah	--			1952, 1958			
74	North Wichita River near Paducah *771	540		1961-66	1958-59, 1965-66	1951-54		1961-66
75	North Wichita River near Truscott *757	937		1959-66	1954, 1956, 1959, 1965-66	1952-57		1959-66
76	South Wichita River at Guthrie	--			1950, 1958-59 1963			
77	South Wichita River tributary 6 miles east of Guthrie	--			1958			
78	South Wichita River 6.5 miles east of Guthrie	--			1953-54, 1956 1958-59			
79	South Wichita River near Benjamin *756	584		1959-66	1949,1953-54,1956 1959, 1965-66	1952-57		1959-66
80	Wichita River near Seymour	1874		1959-66	1953-54, 1958, 1965-66			1959-66
81	Lake Kemp near Mabelle	2086			1939,1942,1946,1952 1954-55, 1964-65		1922-66	
82	Wichita River near Mabelle *752	2086		1959-66	1965-66	1952-58		1959-66
83	Santa Rosa Lake near Vernon	--			1966			
84	Beaver Creek near Electra *751	652		1960-66	1966			1960-66
85	North Buffalo Creek near Iowa Park	--			1961-63	1961-63		1961-63
86	Buffalo Creek near Iowa Park	--			1964-65	1963-65		1963-65
87	Wichita River at Wichita Falls *503	3140		1900-1902, 1910-11, 1938-66	1951			1949-66

See footnote at end of table.

Table 4.--Index of Surface-Water Records for the Red River Basin, Texas--Continued

Refer-ence no.	Stream and location	Drainage area (sq. miles)	Type and period of record					
			Daily chemical quality	Discharge	Periodic chemical quality	Periodic discharge measurements	Reservoir content	Water temperature
88	Lake Wichita at Wichita Falls	--			1944, 1946, 1952 1954, 1959, 1965			
89	Wichita River at Farm Road 171 near Byers	--			1949, 1951, 1958			
90	Lake Kickapoo near Archer City	275			1946, 1952, 1954 1957, 1964-65		1946-66	
91	Little Wichita River near Archer City	481	1953-55	1932-56				1949-56
92	Lake Creek near Henrietta	--			1959			
93	Little Wichita River near Henrietta *704	1037	1953-55, 1959-66	1953-66				1953-66
94	Dry Fork Little Wichita River near Henrietta	--			1959			
95	East Fork Little Wichita River near Henrietta	178		1953-66	1959, 1964-66			1963-66
96	Little Wichita River near Ringgold	1350	1959-62	1959-65				1959-65
97	Red River near Terral, Oklahoma *507	28723		1938-66				1949-66
98	Farmers Creek Reservoir near Nocona				1967			
99	Red River near Gainesville *508	30782	1944-46, 1952-63 1966-67	1936-67				1944-46 1949-66
100	Washita River at Farm Road 2564 near Allison	--			1965	1965		
101	Lake Texoma near Denison	39719					1942-66	
102	Red River at Denison Dam near Denison *522	39720	1944-1967	1923-67				
103	Bois d'Arc Creek near Randolph	72		1962-66	1966			1962-66
104	Sanders Creek near Chicota	--		1961-62 1965-66	1961-62, 1965-66			
105	Red River at Arthur City *527	44531		1905-11, 1936-66	1961-63			
106	Lake Crook near Paris	--		1960				
107	Big Pine Creek near Manchester	--		1961-62	1961-62			
108	Pecan Bayou near Clarksville	100		1962-66				1962-66
109	Red River near New Boston	47555		1960-63				
110	Barkman Creek near Leary	--		1961-62	1961-62			
111	Red River at Index, Ark. *529	48030	1960-63	1936-66				

* U. S. Public Health Service has collected chemical quality records at this site. Number is Public Health Service site number.

Table 5.--Summary of Chemical Analyses of Water at Daily Stations on Streams in the Red River Basin, Texas

(Analyses listed as maximum and minimum were classified on the basis of the values for dissolved solids only; values of other constituents may not be extremes. Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
13. PRAIRIE DOG TOWN FORK RED RIVER NEAR BRICE																						
Water year 1950																						
Maximum, May 16-18,21,1950	10.2	30		650	134	2960		114		1750	4740		--		10300	14.0	284	2170	2080		15200	7.6
Minimum, Oct. 10, 1949	283	26		397	42	205		82		1100	280		2.5		2090	2.84	1600	1160	1100		2680	7.7
Weighted average	69.3	23		327	56	778		110		930	1190		2.9		3360	4.57	629	1050	956		--	--
Water year 1951																						
Maximum, Jan. 15-16, 1951	10.1	25		813	217	4410		153		2270	7110		--		14900	20.3	406	2920	2800		21400	7.8
Minimum, May 17-20	6032	20		202	36	308		110		583	440		3.8		1650	2.24	26900	652	562		2540	8.0
Weighted average	162	23		229	41	454		129		669	663		--		2140	2.92	940	752	647		3370	--
14. MULBERRY CREEK NEAR BRICE																						
Water year 1950																						
Maximum, June 24, 1950	0.25	44		472	144	219		79		1730	270		0.5		2920	3.97	2.0	1770	1700		3480	7.7
Minimum, July 24	204	18		128	17	43		80		334	49		1.8		693	.94	382	391	326		918	8.0
Weighted average	38.2	25		244	43	84		102		697	111		1.7		1260	1.73	131	786	702		1650	--
Water year 1951																						
Maximum Mar. 2, 1951	.40	30		500	113	229		124		1680	255		.0		2870	3.90	3.1	1710	1610		3390	7.4
Minimum, June 1-3	597	28		101	19	36		113		235	49		2.5		526	.75	893	330	238		789	8.0
Weighted average	20.7	31		200	40	83		112		566	115		2.6		1120	1.52	63.0	664	572		1480	--
40. SALT FORK RED RIVER NEAR HEDLEY																						
Water year 1957																						
Maximum, Jan. 18, 1957		34		371	125	261		276		1260	328	1.0	5.6		2520	3.43		1440	1210	3.0	3260	7.8
Minimum, Aug. 29		15		38	7.5	30		111		57	25	.8	3.0		231	.31		126	35	1.1	382	8.0
Water year 1958																						
Maximum, Jan. 1, 3, 1958		28		408	108	185		217		1280	250	.6	.5		2370	3.22		1460	1280	2.1	2860	7.9
Minimum, Oct. 15, 17-18, 1957		17		64	19	104		136		166	125	.8	1.0		575	.78		238	126	2.9	925	7.9
Water year 1959																						
Maximum, Mar. 11-14, 16,20, 22, 25, 28, 1959		24		215	74	278		184		800	325	.9	1.8		1810	2.46		841	690	4.2	2570	7.6
Minimum, Mar. 5		17		72	24	81		100		218	101	.3	1.0		563	.77		278	196	2.1	917	8.2
Water year 1960																						
Maximum, Nov. 8-9, 17-21, 23-30, 1959		46		130	49	145		113		516	148	.9	1.8		1090	1.48		526	434	2.8	1510	7.9
Minimum, June 7-9		13		45	8.5	29		131		59	27	.4	2.0		270	.37		147	40	1.0	413	7.6
Water year 1961																						
Maximum, June 26-29, July 6, 1961		46		92	39	143		78		380	169	.8	.5		968	1.32		390	326	3.1	1370	7.5
Minimum, Oct. 10-16, 1960		19		50	12	49		135		90	52	.6	2.8		347	.47		174	64	3.8	565	7.6

Table 5.--Summary of Chemical Analyses of Water at Daily Stations on Streams in the Red River Basin, Texas--Continued

(Analyses listed as maximum and minimum were classified on the basis of the values for dissolved solids only; values of other constituents may not be extremes. Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
47. SALT FORK RED RIVER NEAR WELLINGTON																						
June to September 1952																						
Maximum, Sept. 21-30, 1952..	3.22	28		558	101	151		135		1690	185	0.8	3.0		2780	3.78	24.2	1810	1700	1.5	3240	7.8
Minimum, June 22-24........	51.4	40		199	47	115		136		621	125	.6	4.8		1220	1.66	169	690	578	1.9	1710	7.9
Water year 1953																						
Maximum, Dec. 18-30, 1952..	15.0	20		600	108	131		174		1650	255	.8	5.8		2860	3.89	116	1940	1800	1.3	3370	7.8
Minimum, Aug. 6, 8, 18-20, 1953..................	194	26		141	25	51		125		359	65	.5	1.5		730	.99	382	455	352	1.0	1080	7.7
Weighted average..........	55.3	29		238	47	102		128		681	134	.7	3.8		1300	1.77	194	788	682	1.6	1730	--
Water year 1954																						
Maximum, Aug. 12-20, 1954..	6.29	29		518	141	613		114		1590	1030	.8	3.5		3980	5.41	67.6	1870	1780	6.2	5470	7.7
Minimum, Oct. 21-24, 1953..	414	14		127	21	53		131		295	71	.4	3.0		677	.92	757	404	296	1.1	960	7.7
Weighted average..........	120	25		188	40	102		141		518	141	.7	3.0		1100	1.50	357	634	518	1.8	1550	--
66. PEASE RIVER NEAR CROWELL																						
July to September 1942																						
Maximum, July 16, 1942.....	--	--		1010	199	2660		99		2910	4260	--	13		11100	--	--	3350	--		16000	
Minimum, June 10..........	--	--		390	79	522		75		1150	835	--	1.2		3010	--	--	1300	--		4460	
Water year 1943																						
Maximum, Dec. 24, 1942.....	49.0	--		864	170	4050		145		2300	6480	--	2.5		14200	18.9	1840	2860	2740		20400	
Minimum, Apr. 17, 1943.....	1060	12		326	33	134		76		847	208	0.6	1.5		1600	2.18	4580	949	886		2420	
Weighted average..........	161	13		424	64	793		112		1130	1250	.4	3.2		3740	5.09	1620	1320	1230		5540	
91. LITTLE WICHITA RIVER NEAR ARCHER CITY																						
January to September 1953																						
Maximum, Aug. 15-17, 1953..	5.87	11		72	25	362		121		14	675	0.8	2.8		1220	1.66	19.3	282	184	9.4	2360	8.0
Minimum, Aug. 20-28	21.1	18		22	5.9	53		113		7.1	65	.5	2.5		230	.31	13.1	79	0	2.6	405	7.9
Weighted average..........	6.1	13		27	8.0	84		114		7.1	128	--	3.9		328	.46	5.52	100	7	3.6	622	--
Water year 1954																						
Maximum, Sept. 19, 1954....	.05	--		--	--	--		165		--	1130	--	--		2340	--	--	590	455	--	3730	8.0
Minimum, Oct. 22-27, 1953..	1542	10		14	3.1	20		59		3.3	25	.5	4.8		137	.19	570	48	0	1.3	192	7.8
Weighted average..........	60.0	12		19	5.1	34		73		4.2	53	.5	3.7		168	.26	31.1	68	9	1.8	303	--
Water year 1955																						
Maximum, Nov. 17-18, 1954..	1.65	8.6		129	37	542		86		13	1110	.4	4.0		1890	2.57	8.42	475	404	11	3550	7.8
Minimum, Sept. 25-26, 1955.	3890	6.4		12	2.4	18		48		7.8	20	.5	4.0		95	.13	998	40	1	1.3	156	7.3
Weighted average..........	64.3	9.7		23	5.5	36		94		5.6	51	.5	4.0		197	.27	34.2	80	3	1.8	337	--
93. LITTLE WICHITA RIVER NEAR HENRIETTA																						
Dec. 1952 - Sept. 1953																						
Maximum, Mar. 15-16........	103	14		94	31	514		81		15	988	--	6.5		1700	2.31	474	362	296	12	3290	8.0
Minimum, Mar. 14, 17-18....	137	9.4		13	4.3	20		59		5.0	27	--	3.5		111	.15	41.1	50	2	1.2	205	7.7
Weighted average..........	12.6	12		23	7.5	73		90		6.4	116	--	4.8		286	.43	10.7	88	14	3.4	542	--
Water year 1954																						
Maximum, Oct. 6, 1953......	185	16		60	18	415		93		14	728	0.8	7.5		1310	1.78	654	224	148	12	2460	7.4
Minimum, Oct. 22-24, 26-29..	3326	7.2		8.2	2.7	11		38		2.6	12	.7	3.0		66	.09	593	32	0	.8	116	7.4
Weighted average..........	204	12		14	4.8	25		58		3.6	39	.7	3.0		147	.20	81.0	55	7	1.5	236	--

Table 5.--Summary of Chemical Analyses of Water at Daily Stations on Streams in the Red River Basin, Texas--Continued

(Analyses listed as maximum and minimum were classified on the basis of the values for dissolved solids only; values of other constituents may not be extremes. Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids (calculated): Tons per acre-foot	Dissolved solids (calculated): Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
93. LITTLE WICHITA RIVER NEAR HENRIETTA--Continued																						
Water year 1955																						
Maximum, Sept. 24, 1955	92.0	11		113	33	481		74		18	980	0.4	2.2		1670	2.27	415	418	358	10	3250	7.8
Minimum, May 19	1430	7.2		7.8	2.3	8.4		34		2	10	.6	2.0		57	.08	220	29	1	.7	97	7.4
Weighted average	114	9.7		19	4.1	36		69		4.3	56	.3	2.4		166	.23	51.7	64	8	1.9	306	--
March to September 1959																						
Maximum, May 12	471	9.6		78	23	345		128		25	642	.6	2.2		1190	1.62	1510	289	184	8.8	2300	7.8
Minimum, June 23	2280	6.4		6.8	3.4	10		39		4.4	10	.2	2.5		63	.09	388	31	0	.8	116	7.2
Weighted average	79.4	8.9		21	6.1	50		69		6.6	85	.3	2.4		218	.30	46.7	78	21	2.5	404	--
Water year 1960																						
Maximum, June 2, 1960	115	--		--	--	--		58		--	2500	--	--		4120	5.60	1280	1060	1010	--	7520	6.3
Minimum, Mar. 26	245	7.8		16	3.8	18		59		6.8	26	.2	2.8		110	.15	72.8	56	7	1.0	204	7.0
Weighted average	62.7	9.3		25	6.9	64		70		7.7	114	.2	1.9		270	.37	45.7	91	33	2.9	498	--
Water year 1961																						
Maximum, June 1-8, 1961	.5	--		--	--	--		94		--	1450	--	--		2440	3.32	3.29	666	589	--	4590	7.0
Minimum, Oct. 15-16, 1960	789	7.3		6.8	2.9	8.8		34		4.0	9.2	.3	2.8		59	.08	126	29	1	.7	104	6.6
Weighted average	51.4	9.3		22	6.2	59		71		6.6	100	.3	2.2		243	.33	33.7	80	22	2.9	458	--
Water year 1962																						
Maximum, Nov. 4, 1961	147	8.8		109	29	505		79		16	1000	.4	7.4		1710	2.33	679	392	327	11	3170	7.2
Minimum, June 30, 1962	918	--		--	--	--		51		4.2	10	--	--		76	.10	188	34	0	--	129	7.0
Weighted average	105	13		23	6.6	52		79		6.1	89	--	3.2		234	.31	66.3	87	21	2.2	436	--
Water year 1963																						
Maximum, Feb. 1-4, 8-14, 16-19, 1963	.1	5.3		210	76	628		170		29	1440	--	1.0		2470	3.36	.67	836	697	9.4	4560	7.6
Minimum, Nov. 24-25, 1962	5.9	--		--	--	--		8		--	8.0	--	--		30	.04	--	8	1	--	44	6.1
Weighted average	101	8.6		17	4.9	33		63		7.8	53	--	1.2		158	.21	66.0	63	12	1.6	290	--
Water year 1964																						
Maximum, Dec. 15-17, 1963	8.6	7.2		74	8.6	306		62		27	570	--	2.2		1020	1.39	23.7	220	169	9.0	1990	7.6
Minimum, Sept. 16-17, 1964	118	11		13	3.1	20		72		8.0	14	.4	1.8		106	.14	33.8	45	0	1.3	182	6.8
Weighted average	56.3	11		25	6.3	56		92		7.5	89	--	2.7		242	.33	73.0	88	17	2.3	455	--
Water year 1965																						
Maximum, Apr. 16-18, 1964	82.7	11		65	18	235		113		17	450	--	3.2		855	1.16	191	236	144	6.7	1600	7.8
Minimum, Aug. 16-17	416	8.4		11	3.1	11		50		6.0	11	.2	1.5		77	.10	86.5	40	0	.8	134	7.0
Weighted average	46.2	9.5		25	6.7	52		85		8.9	87	--	1.0		232	.32	48.0	89	19	2.2	439	--
Water year 1966																						
Maximum, July 12, 1966	75.0	6.6		106	30	343		132		21	710	.5	4.0		1290	1.75	261	388	280	7.5	2490	7.7
Minimum, Apr. 26-30	3788	7.3		12	3.3	16		50		3.2	20	.3	.5		90	.12	920	44	2	.9	162	6.4
Weighted average	203	8.0		15	4.0	25		58		4.7	37	.3	.7		124	.16	172	54	6	1.2	231	--
96. LITTLE WICHITA RIVER NEAR RINGGOLD																						
March to September 1959																						
Maximum, Mar. 16-18, 1959	32.1	7.8		205	63	783		150		34	1640	0.3	2.0		2810	3.82	244	770	648	12	5200	8.1
Minimum, Sept. 4	383	7.6		5.2	1.5	4.3		22		2.6	4.0	.1	2.0		38	.05	39.3	19	1	.4	60	6.9
Weighted average	130	9.6		15	4.3	33		55		5.1	52	.2	2.7		151	.21	53.0	55	10	1.9	279	--
Water year 1960																						
Maximum, June 3, 1960	133	10		302	96	1260		60		62	2680	.5	--		4440	6.04	1590	1150	1100	16	7860	6.8
Minimum, Oct. 3-4, 1959	173	10		4.5	2.9	6.3		33		1.4	5.0	.2	1.0		47	.06	173	23	0	.6	72	7.4
Weighted average	108	11		17	5.4	40		63		6.0	66	.2	1.5		180	.24	52.5	65	13	2.2	326	--

Table 5.--Summary of Chemical Analyses of Water at Daily Stations on Streams in the Red River Basin, Texas--Continued

(Analyses listed as maximum and minimum were classified on the basis of the values for dissolved solids only; values of other constituents may not be extremes. Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
96. LITTLE WICHITA RIVER NEAR RINGGOLD--Continued																						
Water year 1961																						
Maximum, Oct. 8-15, 1960	26.0	6.4		89	23	395		85		18	770	0.4	0.2		1340	1.82	94.1	316	247	9.7	2570	6.7
Minimum, Oct. 16-17	1046	7.4		6.5	2.4	8.4		32		4.2	8.0	.3	2.2		55	.07	155	26	0	.7	99	6.6
Weighted average	80.6	8.8		18	5.4	43		63		6.9	72	.3	1.8		187	.25	40.7	67	15	2 3	354	--
Water year 1962																						
Maximum, Nov. 8-11, 1961	34.1	8.4		112	29	564		64		17	1100	.6	4.0		1870	2.54	42.9	399	346	12	3590	6.8
Minimum, Sept. 6-7, 1962	1900	15		5.0	2.9	2.6		30		.4	3.0	--	1.0		45	.06	231	24	0	.2	67	7.0
Weighted average	164	12		17	5.4	34		66		5.5	54	.3	1.4		168	.23	74.4	65	12	1.6	302	6.7
99. RED RIVER NEAR GAINESVILLE																						
May to September 1944																						
Maximum, Sept. 21-30	276			384	86	1240		144		940	2070		1.8		4790	6.51	3570	1310	1190	--	7530	--
Minimum, June 13-16	957			83	19	163		115		181	252		2.2		757	1.03	1960	285	191	--	1320	--
Weighted average	1459			181	43	433		126		450	705		3.3		1880	2.56	7410	628	525	--	3070	--
Water year 1945																						
Maximum, Jan. 11-20, 1945	504			310	97	1030		214		751	1740		3.5		4040	5.49	5500	1170	997	--	6550	--
Minimum, Sept. 30	42300			36	7.3	36		94		31	62		1.2		250	.34	28600	120	43	--	403	--
Weighted average	4193			97	24	194		137		169	335		3.5		891	1.21	10100	340	228	--	1540	--
October 1945 to April 1946																						
Maximum, Jan. 23-31, 1946	1206			248	75	866		287		521	1440		2.5		3290	--	--	928	692	--	5510	--
Minimum, Oct. 1-3, 1945	6547			36	7.3	36		94		31	62		1.2		250	--	--	120	43		403	--
Weighted average	--			--	--	--		--		--	--		--		--	--	--	--	--	--	--	--
Water year 1953																						
Maximum, Apr. 1-11, 1953	2740			450	94	1730		153		1190	2750		7.0		6480	8.81	47940	1510	1380	19	9890	7.4
Minimum, July 22-23	3090			39	8.4	66		105		42	101		4.2		342	.47	2850	132	46	2.5	584	8.0
Weighted average	651			169	38	436		127		412	698		4.6		1910	2.60	3360	578	474	7.8	3010	--
Water year 1954																						
Maximum, Aug. 30-31	804			460	86	1140		123		1190	2000		--		5210	7.09	11310	1500	1400	13	8010	8.1
Minimum, May 12-13	41950			52	6.2	74		102		70	114		1.4		412	.56	46670	155	72	2.6	698	8.0
Weighted average	3090			115	23	242		123		246	394		--		1140	1.55	9510	382	280	5.4	1890	--
Water year 1955																						
Maximum, Aug. 1-6, 1955	1303			356	73	867		126		900	1400		--		3830	5.21	13470	1190	1090	11	6000	7.4
Minimum, Sept. 26-30	14660			48	12	83		120		70	118		1.7		400	.54	15830	170	72	2.8	732	7.7
Weighted average	2630			141	32	282		130		326	462		--		1370	1.86	9730	484	377	5.6	2270	--
Water year 1956																						
Maximum, June 21-31, 1956	530			424	103	1370		134		1120	2250		--		5490	7.47	7860	1480	1370	15	8670	8.1
Minimum, July 11	1220			45	12	89		90		57	155		3.3		446	.61	1470	160	86	3.1	776	8.0
Weighted average	2177			146	37	323		136		341	533		--		1530	2.08	8990	516	405	6.2	2470	--
Water year 1957																						
Maximum, Sept. 11-12, 1957	445			384	69	1020		118		917	1700		--		4260	5.79	5120	1240	1140	13	6630	7.6
Minimum, Apr. 26-30	49580			51	7.5	49		130		58	67		2.4		335	.46	44850	158	52	1.7	553	8.2
Weighted average	7484			107	23	169		136		209	283		--		917	1.25	18530	362	250	3.9	1520	--
Water year 1958																						
Maximum, Nov. 1-3	683			344	78	1110		196		793	1850		--		4680	6.36	8630	1180	1020	14	7460	8.1
Minimum, Nov. 4	1110			28	3.2	6.4		84		14	7.0		4.6		115	.16	345	83	14	.3	176	7.7
Weighted average	1998			164	44	434		151		383	717		--		1950	2.65	10520	590	466	7.8	3100	--

Table 5.--Summary of Chemical Analyses of Water at Daily Stations on Streams in the Red River Basin, Texas--Continued

(Analyses listed as maximum and minimum were classified on the basis of the values for dissolved solids only; values of other constituents may not be extremes. Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated) Milligrams per liter	Tons per acre-foot	Tons per day	Hardness as $CaCO_3$ Calcium, Magnesium	Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
99. RED RIVER NEAR GAINESVILLE--Continued																						
Water year 1959																						
Maximum, April 20, 1959....	652	--		300	100	1170		116		815	1950		--	--	4690	6.38	8260	1160	1060	15	7150	8.0
Minimum, Sept. 5...........	1960	--		48	16	93		104		73	60		0.8	--	472	.64	2500	185	100	3.0	802	7.7
Weighted average...........	1534	--		154	31	359		125		375	566		--	--	1640	2.23	6790	512	409	6.9	2560	--
Water year 1960																						
Maximum, July 1-8, 1960....	799	--		348	90	1190		138		990	1900		--	--	4760	6.47	10270	1240	1130	15	7080	8.0
Minimum, Oct. 4, 1959......	27900	--		36	6.3	32		108		32	45		.4	--	217	.30	16350	116	28	1.3	362	7.9
Weighted average...........	2916	--		147	36	364		144		342	590		--	--	1660	2.26	13070	515	397	7.0	2590	--
Water year 1961																						
Maximum, July 16-18, 1961..	2143	--		416	100	1340		132		1210	2120		--	--	5630	7.66	32580	1450	1340	15	8050	8.0
Minimum, Sept. 16-20.......	5412	--		48	12	95		118		66	146		3.6	--	463	.63	6770	168	72	3.2	785	8.0
Weighted average...........	3044	--		158	43	399		148		390	644		--	--	1820	2.48	14960	571	450	7.3	2830	--
Water year 1962																						
Maximum, April 18-22, 1962.	311	--		252	120	923		184		718	1580		--	0.57	3880	5.28	3260	1120	969	12	6180	7.9
Minimum, Sept. 2...........	835	--		46	3.6	21		140		31	21		--	--	221	.30	498	130	16	.8	294	7.8
Weighted average...........	2591	--		124	29	287		140		283	456		--	--	1340	1.82	9370	429	314	6.0	2120	--
Water year 1963																						
Maximum, June 26-July 1, 1963	751	--		392	69	1550		146		1150	2350		--	.43	5580	7.59	11310	1260	1140	19	8800	8.2
Minimum, Nov. 26, 1962.....	4220	--		58	8.6	23		148		72	19		--	.06	292	.40	3330	180	52	.7	460	8.4
Weighted average...........	1289	--		141	36	381		150		324	611		--	.26	1590	2.16	5540	498	372	7.0	2660	8.2
Water year 1967																						
Maximum, Mar. 1-31, 1967...	179	4.6		258	86	812	8.1	232		610	1400		2.5	--	3310	4.50	1600	997	807	11	5350	7.6
Minimum, July 7-8..........	5110	7.9		56	10	86	4.4	126		60	146	0.2	.2	--	433	.59	5970	180	77	2.8	787	7.9
Weighted average...........	1316	7.9		140	30	329	5.8	141		302	545		1.3	--	1430	1.94	5080	473	358	6.0	2400	7.5
102. RED RIVER AT DENISON DAM NEAR DENISON																						
May to September 1944																						
Maximum, Aug. 11-20, 1944..	746	--		148	37	315		162		323	520		4.9		1430	1.94	2880	522	389	--	2430	7.8
Minimum, June 11-20........	204	--		98	26	194		158		183	318		4.8		902	1.23	497	352	222	--	1610	7.9
Weighted average...........	297	--		126	32	255		161		255	424		4.2		1180	1.60	946	446	314	--	2040	--
Water year 1945																						
Maximum, Jan. 1-10, 1945...	149	--		127	34	296		172		290	465		2.0		1300	1.77	523	457	316	--	2280	8.0
Minimum, July 1-10.........	25880	--		68	19	84		149		98	146		.8		489	.67	34200	248	9	--	852	8.0
Weighted average...........	7261	--		78	21	114		140		129	195		1.7		607	.83	11900	281	166	--	1070	--
Water year 1946																						
Maximum, Aug. 11-20, 1946..	2043	--		71	23	115		165		106	195		1.0		592	.91	3680	272	3	--	1050	--
Minimum, Oct. 11-20, 1945..	36430	--		62	17	63		134		86	115		.5		410	.65	47000	224	114	--	762	--
Weighted average...........	6199	--		67	19	84		152		100	139		.9		486	.73	9000	245	120	--	874	--
Water year 1947																						
Maximum, Oct. 20-31, 1946..	2347	--		143	34	298		145		321	490		1.5		1360	1.85	8620	497	378	--	2290	--
Minimum, Oct. 1-10.........	2528	--		70	23	116		163		120	185		1.5		644	.88	4400	269	136	--	1070	--
Weighted average...........	7923	--		90	24	149		148		164	250		2.0		805	1.09	17200	323	202	--	1340	--
Water year 1948																						
Maximum, Sept. 1-30, 1948..	2124	10		92	27	170		137		184	288		.8		905	1.23	5190	340	228	--	1500	--
Minimum, Dec. 1-31, 1947...	2351	--		78	23	141		134		176	215		.5		762	1.04	4840	289	179	--	1230	--
Weighted average...........	3528	--		85	24	150		140		175	239		1.5		797	1.08	7590	310	196	--	1310	--
Water year 1949																						
Maximum, July 1-31, 1949...	2307	12		100	25	209		135		217	332		2.8		1040	1.41	6480	352	242	--	1710	--
Minimum, Nov. 1-30, 1948...	2166	7.8		85	24	150		131		175	246		.8		774	1.05	4530	310	203	--	1340	--
Weighted average...........	3880	8.6		91	26	178		137		193	290		1.9		901	1.23	9440	334	222	--	1520	--

Table 5.--Summary of Chemical Analyses of Water at Daily Stations on Streams in the Red River Basin, Texas--Continued

(Analyses listed as maximum and minimum were classified on the basis of the values for dissolved solids only; values of other constituents may not be extremes. Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
102. RED RIVER AT DENISON DAM NEAR DENISON--Continued																						
Water year 1950																						
Maximum, Mar. 1-31, 1950...	1772	11		96	27	186		129		215	300	--	3.5	--	977	1.33	4670	350	245	--	1600	--
Minimum, Sept. 1-30........	10330	12		78	21	156		126		165	245	--	2.0	--	790	1.07	22000	281	178	--	1320	--
Weighted average..........	7049	13		88	24	174		130		191	276	--	3.1	--	882	1.20	16800	318	212	--	1460	--
Water year 1951																						
Maximum, June 1-30, 1951...	25960	11		99	29	198		149		207	325	--	.8	--	1010	1.37	70800	366	244	--	1670	8.0
Minimum, Sept. 1-30........	2563	14		77	21	143		132		157	225	--	1.0	--	725	.99	5020	278	170	--	1220	7.6
Weighted average..........	6992	11		91	25	179		141		187	290	--	1.2	--	913	1.24	17200	330	214	--	1500	--
Water year 1952																						
Maximum, Aug. 1-31, 1952...	3140	8.2		89	27	183		145		200	285	--	2.0	--	894	1.22	7580	333	214	4.3	1530	7.9
Minimum, Oct. 1-31, 1951...	1841	11		68	23	144		135		160	212	--	2.0	--	722	.99	3590	264	154	3.9	1180	7.8
Weighted average..........	2301	9.5		83	26	161		142		185	250	--	1.9	--	827	1.12	5140	314	198	3.9	1380	--
Water year 1953																						
Maximum, Aug. 1-31, 1953...	2932	11		92	28	197		140		205	315	--	1.0	--	995	1.35	7880	344	230	4.6	1620	8.0
Minimum, Oct. 1-31, 1952...	2394	11		88	28	188		140		203	295	--	1.2	--	912	1.24	5890	334	220	4.5	1520	7.9
Weighted average..........	1853	9.5		92	29	190		142		207	305	--	1.9	--	944	1.28	4720	348	232	4.4	1570	--
Water year 1954																						
Maximum, Nov. 1-30, 1953...	1186	8.8		100	27	233		123		239	370	0.5	1.0	0.18	1040	1.41	3330	360	260	5.3	1750	7.9
Minimum, July 1-31, 1954...	4608	15		84	21	165		128		178	275	.3	2.0	.20	830	1.13	10330	296	191	4.2	1390	7.9
Weighted average..........	3950	12		89	24	184		128		200	299	.4	1.7	.18	908	1.23	9680	320	216	4.5	1530	--
Water year 1955																						
Maximum, Sept. 1-30, 1955..	2688	11		106	21	216		122		240	342	.4	1.2	.14	1000	1.36	7260	351	251	4.9	1720	7.8
Minimum, Oct. 1-31, 1954...	1109	12		86	22	177		122		190	278	.4	1.5	.08	880	1.20	2630	305	205	4.4	1480	7.7
Weighted average..........	2762	9.9		96	22	193		126		209	306	.3	1.5	.14	937	1.27	6990	330	227	4.5	1570	--
Water year 1956																						
Maximum, Sept. 1-30, 1956..	1423	12		128	32	280		126		315	448	.5	.5	.20	1280	1.74	4920	450	346	5.7	2190	7.8
Minimum, Jan. 1-31.........	3627	11		102	21	198		121		228	305	.3	.9	.17	954	1.30	9340	341	242	4.6	1600	7.9
Weighted average..........	3550	11		106	23	223		122		248	346	.4	1.1	.17	1030	1.40	9870	359	259	5.0	1720	--
Water year 1957																						
Maximum, Dec. 1-31, 1956...	677	12		134	32	311		123		342	485	--	.7	--	1380	1.88	2520	465	364	6.3	2290	7.8
Minimum, June 1-30, 1957...	66910	11		78	15	133		107		165	202	--	1.8	--	696	.95	125700	256	168	3.6	1130	7.6
Weighted average..........	10890	11		89	18	167		112		195	258	--	2.2	--	840	1.14	24700	296	204	4.2	1370	--
Water year 1958																						
Maximum, Sept. 1-30, 1958..	1614	9.4		100	24	220		148		209	345	--	.5	--	981	1.33	4280	348	226	5.1	1700	8.0
Minimum, Oct. 1-31, 1957...	5720	15		85	20	144		132		173	225	--	1.2	--	733	1.00	11320	294	186	3.6	1240	8.2
Weighted average..........	4320	11		91	20	171		136		185	268	--	1.0	--	837	1.14	9760	309	198	4.2	1400	--
Water year 1959																						
Maximum, Aug. 1-31, 1959...	4623	10		112	27	260		131		259	408	--	.4	--	1140	1.55	14230	390	283	5.7	1900	7.4
Minimum, Oct. 1-31, 1958...	1823	8.8		99	24	234		138		218	365	--	.5	--	1020	1.39	5020	346	232	5.5	1770	8.2
Weighted average..........	2298	9.4		104	28	252		135		246	390	--	.8	--	1100	1.50	6830	374	264	5.7	1880	--
Water year 1960																						
Maximum, Sept. 1-30, 1960..	1930	12		113	28	264		153		266	400	.6	2.5	--	1160	1.58	6040	397	272	5.8	1960	7.5
Minimum, May 1-31..........	2703	8.6		99	25	187		155		223	280	.3	1.0	--	900	1.22	6570	350	223	4.3	1530	7.5
Weighted average..........	5203	9.5		101	26	222		129		238	343	.4	1.7	--	1020	1.39	14330	359	254	5.1	1710	--

Table 5.--Summary of Chemical Analyses of Water at Daily Stations on Streams in the Red River Basin, Texas--Continued

(Analyses listed as maximum and minimum were classified on the basis of the values for dissolved solids only; values of other constituents may not be extremes. Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
102. RED RIVER AT DENISON DAM NEAR DENISON--Continued																						
Water year 1961																						
Maximum, Sept. 1-30, 1961..	3593	11		120	37	300		138		312	470	0.3	2.8		1320	1.80	12810	452	338	6.2	2210	7.7
Minimum, Oct. 1-31, 1960...	12040	9.4		110	33	263		128		286	410	--	.4		1170	1.59	38030	410	305	5.7	2010	7.6
Weighted average...........	4299	9.9		117	33	278		134		297	431	.3	1.2		1230	1.67	14280	428	318	5.8	2100	--
Water year 1962																						
Maximum, Oct. 1-31, 1961...	4814	9.9		121	37	297		130		316	470	.4	.5		1320	1.80	17160	454	348	6.1	2220	7.2
Minimum, Sept. 1-30, 1962..	3772	11		100	30	238		139		256	360	.4	1.2		1060	1.44	10800	373	259	5.4	1800	7.3
Weighted average...........	4527	8.9		111	34	253		136		277	403	.4	1.4		1150	1.56	14100	420	308	5.4	1980	--
Water year 1963																						
Maximum, Sept. 1-30, 1963..	1501	9.2		105	31	225		150		249	350	.4	1.8		1050	1.43	4260	390	266	5.0	1820	6.9
Minimum, Apr. 1-30, 1963...	2862	8.5		98	27	199		140		236	302	.3	1.0		941	1.28	7270	356	241	4.6	1570	7.7
Weighted average...........	3029	9.3		99	29	211		133		244	326	.4	1.2		989	1.35	8090	366	256	4.8	1670	--
Water year 1964																						
Maximum, Sept. 1-30, 1964..	1177	8.1		111	35	298		160		300	440	.4	1.8		1270	1.73	4036	418	288	6.3	2060	7.3
Minimum, Nov. 1-30, 1963...	803	8.4		111	35	253		130		285	402	.4	.2		1160	1.58	2515	421	314	5.4	2000	7.4
Weighted average...........	1510	8.4		111	35	267		135		290	420	.4	1.2		1200	1.63	4900	422	312	5.6	2040	--
Water year 1965																						
Maximum, Nov. 1-30, 1964...	815	6.2		108	35	283		120		296	440	.3	1.8		1230	1.67	2710	414	316	6.1	2060	7.4
Minimum, May 1-31, 1965....	1939	4.4		96	30	209		135		236	325	.4	2.2		969	1.32	5070	363	252	4.8	1720	7.2
Weighted average...........	1943	5.6		101	30	238		135		251	373	.3	1.1		1070	1.46	5610	376	266	5.3	1850	--
Water year 1966																						
Maximum, Mar. 1-31, 1966...	1310	1.0		108	30	261		127		272	442	.4	1.8		1180	1.60	4170	393	289	5.7	2040	7.0
Minimum, Oct. 1-31, 1965...	2056	3.2		101	32	247		126		246	400	.4	1.0		1090	1.48	6050	385	282	5.4	1940	7.2
Weighted average...........	2813	2.4		110	30	255		138		264	403	.4	.8		1130	1.54	8610	397	284	5.5	1980	--
Water year 1967																						
Maximum, Feb. 1-28, 1967...	1931	4.5		114	29	273	5.5	123		292	438	.1	.8		1220	1.66	6360	404	303	5.9	2070	7.1
Minimum, Aug. 1-31, 1967...	2840	2.3		99	25	220	5.2	122		228	355	.4	1.0		996	1.35	7640	350	250	5.1	1720	7.2
Weighted average...........	2339	2.5		106	28	248	5.4	123		253	404	.4	1.0		1110	1.50	6990	380	279	5.5	1920	7.2
111. RED RIVER AT INDEX, ARK.																						
Water year 1961																						
Maximum, Sept. 6-10, 1961..	3112			118	37	255		172		275	405		1.0		1260	1.71	10590	445	304	5.3	2020	8.0
Minimum, May 9-14, 1961....	25000			29	4.3	30		76		38	38		.8		185	.25	12490	90	28	1.4	306	8.0
Weighted average...........	10190			75	20	139		116		161	219		.8		728	.99	26000	269	173	3.5	1200	7.8
Water year 1962																						
Maximum, Oct. 21-31, 1961..	6577			--	--	245		136		268	405		--		1180	1.60	20950	430	318	5.1	1940	7.7
Minimum, June 6-9, 1962....	14600			--	--	21		92		24	24		--		157	.21	6190	88	12	1.0	271	7.5
Weighted average...........	10930			--	--	111		116		122	177		--		609	.83	18000	230	134	2.9	972	7.9
Water year 1963																						
Maximum, Sept. 12-14, 1963.	2300			--	--	217		148		245	348		--		1090	1.48	6770	396	275	4.7	1740	8.1
Minimum, May 1-6...........	25883			--	--	40		104		47	62		--		292	.40	24600	138	49	1.5	476	8.3
Weighted average...........	6970			--	--	96		121		110	149		--		538	.73	10120	218	115	2.6	887	7.9

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
2. BUFFALO LAKE NEAR UMBARGER																						
May 2, 1951.......		4.6	0.09	44	31	81	14	372		73	27	2.0	2.0	0.11	472	0.64		238	0		804	8.2
6. PRAIRIE DOG TOWN FORK RED RIVER ABOVE STOCKTON DAM NEAR CANYON																						
Apr. 26, 1965.....	b0.08	13		32	12	122		288		96	32	5.0	0.8		455	0.62		130	0	4.6	727	8.3
Aug. 24...........	.20	17		35	14	27		185		28	13	1.4	.2		227	.31		145	0	1.0	393	7.2
7. LAKE STOCKTON NEAR CANYON																						
Feb. 4, 1965......		0.3		42	20	43		237		49	22	1.5	0.2		295	0.40		188	0	1.4	542	7.5
Nov. 17...........		.7		34	8.5	15		152		16	6.8	.8	.2		157			120	0	.6	300	6.8
Aug. 10, 1966.....		3.0		34	14	28	8.0	180		38	17	1.1	1.0		233			142	0	1.0	421	7.1
Jan. 20, 1967.....		.1		35	17	34	9.3	203		43	20	1.2	.2		260			157	0	1.2	466	7.5
Aug. 25...........		.9		29	17	41	9.0	185		49	25	1.5	2.0		265			142	0	1.5	460	7.8
9. PRAIRIE DOG TOWN FORK RED RIVER ABOVE PALO DURO PARK NEAR CANYON																						
Dec. 1, 1961......	0.57	38		185	42	133		197		668	42	3.1	0.0		1210	1.65		634	472	2.3	1550	7.3
10. PRAIRIE DOG TOWN FORK RED RIVER BELOW PALO DURO PARK NEAR CANYON																						
Oct. 18, 1950.....	--	38		314	60	89		108		1040	36	--	0.5		1720	2.22		854	765	--	1950	7.8
Dec. 1, 1961......	0.27	42		448	82	213		125		1660	58	2.4	.0		2570	3.50		1460	1350	2.4	2800	7.3
Dec. 2, 1964......	.15	26		468	100	110		172		1540	50	1.8	.0		2380	3.24		1580	1440	1.2	2540	7.8
Feb. 4, 1965......	.40	27		510	82	162		144		1690	55	2.7	.0		2600	3.54		1610	1490	1.7	2900	7.3
Apr. 26...........	.21	35		492	95	180		102		1770	54	2.6	.2		2680	3.64		1620	1530	1.9	2920	7.0
Aug. 24...........	b.28	27		462	70	137		144		1480	52	2.4	.2		2300	3.13		1440	1320	1.6	2660	7.3
11. NORTH TULE DRAW AT RESERVOIR NEAR TULIA																						
May 2, 1951.......		4.8	0.17	48	12	17	8.8	233		17	8.0	1.6	1.5	0.05	234	0.32		169	0		414	8.2
12. TULE CREEK NEAR SILVERTON																						
Sept. 24, 1964....	13.3	12		34	7.8	14		147		18	4.4	0.9	0.5		164	0.22		117	0	0.6	280	6.9
Jan. 7, 1965......	.50	23		23	49	93		340		138	42	4.4	.2		521	.71		259	46	2.5	832	8.6
June 11...........	4310	15		37	8.0	13		165		11	2.0	.9	1.2		169	.23		125	0	.5	291	6.8
June 11...........	12100	18		48	12	16		222		13	3.6	1.0	.2		221	.30		169	0	.5	380	6.8
June 13...........	186	12		34	6.1	13		142		15	2.9	.7	.5		154	.21		110	0	.5	266	6.6
July 14...........	.70	22		50	21	58		232		98	2.8	2.6	.2		394	.54		212	22	1.7	646	7.8
Aug. 12...........	.72	14		40	17	69		182		125	24	2.5	.2		381	.52		170	21	2.3	635	6.9
Nov. 16...........	.2	12		47	31	99	14	259		190	54	4.0	.2		580	--		247	34	2.7	950	7.6
Mar. 10, 1966.....	.2	19		51	49	115	15	376		191	53	6.6	.0		685	--		328	20	2.8	1090	8.0
June 14...........	8.1	21		44	36	70	12	274		112	46	4.2	1.0		481	--		258	34	1.9	807	7.4
Aug. 10...........	6.3	14		49	10	15	8.8	187		38	5.1	1.3	2.2		235	--		163	10	.5	392	7.3
Aug. 25...........	185	11		41	6.5	5.7	7.4	160		9.6	3.6	.6	1.5		166	--		129	0	.2	297	7.0
16. LITTLE RED RIVER AT STATE HIGHWAY 70 NEAR TURKEY																						
Mar. 24, 1959.....	b0.02			2000	1190	73200		119		5980	115000							9900	9790		152000	7.8

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) [a]	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids (calculated): Tons per acre-foot	Dissolved solids (calculated): Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
17. PRAIRIE DOG TOWN FORK RED RIVER NEAR ESTELLINE																						
July 29, 1949.....	0.5									1520	820										4940	
Sept. 11, 1950....	1000							130		876	1110		2.0								4910	7.9
18. ESTELLINE SPRING NEAR ESTELLINE																						
Feb. 12, 1959.....	4.1			1510	283	17700		144		4380	27200							4930	4810		61600	7.9
Mar. 24..........	--			1500	270	17400		139		4290	27000							4840	4730		61500	7.7
Apr. 30, 1960.....	--			1460	302	16800		230		4220	25800							4870	4690		60600	6.5
May 30, 1962......	5.05	14		1470	275	16200		91		4160	25300				47500	64.6		4790	4710		57900	7.2
19. BAYLOR CREEK RESERVOIR NEAR CHILDRESS																						
Aug. 19, 1949.....		18		179	28	11		83		488	7		0.2		765	1.04		562	494		963	7.9
Mar. 10, 1950.....				216	20	16		98		541	8.0		.5		930			621	540		1110	
20. BAYLOR CREEK NEAR CHILDRESS																						
Mar. 1, 1948......		11		96	12	6.7		61		230	8.0		3.2		430			289			562	
Mar. 3...........		5.0	0.1	100	9.7	4.6		46		242	10				415			290	252			7.8
21. SALT CREEK 12 MILES NORTHWEST OF CHILDRESS																						
Mar. 24, 1959.....				1030	213	5990		110		2860	9500							3450	3360		27200	7.6
22. PRAIRIE DOG TOWN FORK RED RIVER NEAR CHILDRESS																						
Sept. 23, 1948....		15		1750	459	21400		106		4980	33700				62200			6250	--		77100	--
Mar. 24, 1959.....		--		1860	407	23500		86		5440	36500				--			6320	6250		77200	8.0
Apr. 21, 1963.....		9.8		1740	393	20600		96		4970	32300				60100	81.8		5960	5880		61300	6.9
23. BUCK CREEK NEAR WELLINGTON																						
Sept. 17, 1945....	2.0	--		--	--	--		120		2000	235		2.0		--	--		1960	--	--	--	--
Oct. 21, 1947.....	--	--		574	147	206		105		1870	320		.8		3170	--		2040	--	--	3710	--
Sept. 23, 1948....	--	22		606	134	258		120		2100	240		1.5		3420	--		2060	--	--	3660	--
Feb. 26, 1951.....	11.5	19		408	116	96		168		1340	120		3.0		2180	2.96		1500	1360	--	2530	7.3
July 16..........	.7	23		608	132	170		73		1960	232		4.0		3160	4.30		2060	2000	--	3580	7.7
Aug. 15..........	1.3	35		622	138	167		70		2000	242		3.0		3240	4.41		2120	2060	--	3610	7.6
Oct. 8, 1952......	1.24	22		608	141	177		102		1940	265		7.5		3210	4.37		2100	2010	1.7	3860	8.0
May 11, 1953......	3.06	15		568	130	142		73		1800	225		12		2930	3.98		1950	1890	1.4	3360	7.9
Jan. 12, 1955.....	2.68	29		568	125	137		77		1770	225		7.0		2900	3.94		1930	1870	1.4	3320	7.8
Jan. 12, 1956.....	3.57	19		574	117	196		157		1790	242		6.6		3020	4.11		1910	1780	1.9	3380	7.8
Mar. 22, 1959.....	b.08	--		390	187	125		247		1610	94		--		--	--		1740	1540	1.3	2860	7.8
Aug. 2, 1962......	--	16		184	44	46		167		522	42	0.5	.1		982	1.34		640	530	.8	1250	6.7
24. RED RIVER NEAR QUANAH																						
Mar. 25, 1959.....				721	197	2670		154		2310	4170							2610	2480	23	14300	7.7

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
25. NORTH GROESBECK CREEK NEAR NORTH GROESBECK																						
July 16, 1951	5.23	21		624	127	382		176		1900	555		5.9		3700	5.03		2080	1940	--	4760	7.8
Jan. 22, 1952	4.14	20		--	--	--		--		1830	530		.0		--	--		--	--	--	4410	--
Dec. 8, 1953	2.84	16		--	--	--		--		1810	570		5.9		--	--		--	--	--	4550	--
Feb. 19, 1957	1.82	16		636	125	520		151		1890	805		6.0		4070	5.54		2100	1980	4.9	5220	7.9
Aug. 20, 1958	2.33	27		660	130	530		192		1920	830		8.8		4200	5.71		2180	2020	4.9	5360	8.1
Oct. 3, 1961	1.90	--		--	--	522		188		1960	780		--		--	--		2160	2010	--	5100	7.4
26. SOUTH GROESBECK CREEK NEAR GOODLETT																						
June 7, 1962	6.25	26		32	4.4	12		98		32	4.0	0.2	4.1		163	0.22		98	18	0.5	230	7.4
27. SOUTH GROESBECK CREEK NEAR ACME																						
July 16, 1951	6.05	22		614	99	197		157		1750	292		6.5		3060	4.16		1940	1810	--	3630	7.8
Jan. 22, 1952	4.00	17		612	102	179		203		1690	290		1.8		2990	4.07		1950	1780	1.8	3560	7.9
Dec. 8, 1953	4.57	13		--	--	--		--		1720	270		5.1		--	--		--	--	--	3570	--
Feb. 19, 1957	2.09	18		600	84	201		137		1700	280		4.3		2950	4.01		1840	1730	2.0	3470	7.9
Aug. 20, 1958	4.66	20		595	97	151		93		1730	235		3.8		2880	3.92		1880	1810	1.5	3300	8.0
Oct. 3, 1961	4.36	--		--	--	198		172		1750	240		--		--	--		1870	1730	--	3340	7.3
28. GROESBECK CREEK AT STATE HIGHWAY 283 NEAR QUANAH																						
Apr. 21, 1950	--	29		580	48	411		90		1790	425	--	1.2		3330	4.53		1640	1570	--	3590	7.8
Jan. 15, 1951	11.0	14		582	122	271		150		1780	400	--	4.5		3250	4.42		1950	1830	--	3810	7.8
Mar. 15	10.0	15		564	117	292		102		1770	420	--	5.0		3230	4.39		1890	1800	--	3990	7.9
July 16	14.3	18		590	108	277		125		1780	398	--	2.8		3230	4.39		1920	1810	--	3950	7.9
Aug. 15	8.85	25		598	117	330		78		1940	428	--	3.5		3480	4.73		1970	1910	--	4030	7.6
Oct. 1	9.96	15		598	116	282		141		1800	418	--	3.0		3300	4.49		1970	1850	2.8	4010	7.7
Nov. 18	9.92	15		600	118	264		148		1760	425	--	5.0		3260	4.43		1980	1860	6.2	3980	7.6
Jan. 22, 1952	9.66	23		600	115	246		190		1710	400	--	4.5		3190	4.34		1970	1810	2.4	3900	7.8
July 15	83.6	22		254	52	117		106		714	190	--	3.5		1400	1.90		848	760	1.7	1830	7.9
Jan. 13, 1953	6.50	14		586	117	307		84		1830	448	--	5.4		3350	4.56		1940	1870	3.0	4050	7.9
May 11	.34	12		610	131	284		72		1870	472	--	8.2		3420	4.65		2060	2000	2.7	4170	7.9
Dec. 8	11.0	15		--	--	268		--		1740	415	--	4.4		--	--		--	--	--	4070	--
Feb. 19, 1957	.56	14		592	102	359		132		1740	535	--	3.8		3410	4.64		1900	1790	3.6	4290	7.9
Oct. 21	--	28		532	90	231	7.8	90		1540	375	--	5.2		2850	3.88		1700	1620	2.4	3570	--
Jan. 10, 1958	--	21		632	98	247		204		1690	415	--	6.0		3210	4.37		1890	1810	2.4	3930	7.7
Aug. 20	4.72	26		585	109	320		75		1830	450	--	2.5		3360	4.57		1910	1850	3.2	4020	7.5
Sept. 7, 1960	3.32	18		450	83	209		135		1330	298	0.3	2.8		2460	3.35		1460	1350	2.7	3030	7.7
Dec. 8, 1965	4.0	8.3		630	114	242		198		1760	403	--	3.8		3260	--		2040	1880	2.3	4010	7.2
May 31, 1966	2.3	3.5		660	121	328	5.3	151		1980	538	.4	2.2		3710	--		2140	2020	3.1	4510	7.1
July 5	1.6	5.0		658	124	347	8.7	96		1950	560	.4	.8		3700	--		2150	2070	3.3	4420	7.6
29. WANDERERS CREEK AT ODELL																						
Feb. 20, 1950	4.54	8.4		104	66	126		188		415	150		7.8		1140	1.56		531	377	--	1600	7.7
Dec. 17, 1951	3.98	16		--	--	--		--		524	170		11		--	--		--	--	--	1720	--
July 15, 1952	77.8	21		--	--	22		106		52	13		2.8		205	.28		114	27	0.9	329	7.9
Jan. 13, 1953	2.04	18		139	74	158		384		446	148		10		1180	1.60		652	337	2.7	1770	7.8
May 14	1.15	24		90	50	104		321		237	92		21		840	1.14		430	166	2.2	1200	--

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids (calculated): Tons per acre-foot	Dissolved solids (calculated): Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
29. WANDERERS CREEK AT ODELL--Continued																						
Oct. 31, 1953.....	6.69	22		--	--	--		187		662	193	--	9.5		--	--		770	617	--	2090	8.0
Dec. 8, 1953......	2.73	20		--	--	177		--		610	195	--	8.3		--	--		--	--	--	2170	--
Feb. 19, 1957.....	2.40	22		114	67	155		353		399	128	0.8	11		1070	1.46		560	270	2.8	1670	8.1
Oct. 21...........	6.5	32		186	64	131	5.6	368		493	138	--	12		1240	1.69		727	425	2.1	1720	--
Jan. 10, 1958.....	6.02	15		263	103	248		418		906	230	.7	10		1980	2.69		1080	738	3.3	2620	8.0
Aug. 20...........	1.22	37		46	38	91		165		199	81	--	15		616	.84		272	136	2.4	928	8.2
Sept. 6, 1960.....	1.08	28		55	36	80		228		158	64	.6	21		555	.75		285	98	2.1	860	7.9
30. CARROLL CREEK NEAR CLARENDON																						
July 20, 1951.....	0.14	44		36	19	32		209		43	15		1.5		294	0.40		168	0	--	450	8.2
Jan. 23, 1952.....	--	30		--	--	--		--		34	14		.0		--	--		--	--	--	551	--
Jan. 13, 1953.....	1.29	32		31	20	23		190		31	13		2.8		254	.35		160	4	0.8	488	8.2
Aug. 24...........	.44	44		--	--	30		208		48	15		1.8		--	--		177	6	1.0	468	8.2
32. GREENBELT RESERVOIR NEAR CLARENDON																						
May 15, 1967......		13		56	20	43	5.2	198		97	42	1.2	0.5		375			222	60	1.3	621	7.7
33. SALT FORK RED RIVER NEAR CLARENDON																						
Sept. 12, 1950....	--	23		55	18	42		196		75	44	--	1.0		415	0.56		211	50	--	600	8.2
Nov. 4............	12.4	23		40	22	52		148		106	48	--	4.5		400	.54		190	69	--	589	7.9
Jan. 15, 1951.....	17.0	19		53	21	35		190		79	40	--	1.0		388	.53		218	63	--	609	8.0
Feb. 13...........	9.3	23		67	22	34		212		92	43	--	1.5		386	.52		258	84	--	659	7.5
Mar. 2............	10.6	26		61	24	36		202		106	37	--	1.5		402	.55		250	83	--	628	7.5
Mar. 21...........	12	22		53	21	32		164		79	50	--	1.0		342	.47		218	84	--	626	8.2
Apr. 12...........	6.66	32		44	21	46		182		88	38	--	2.5		360	.49		196	48	--	673	8.2
July 20...........	1.16	40		56	21	72		144		137	85	--	1.0		498	.68		226	108	--	774	8.2
Jan. 23, 1952.....	--	28		--	--	--		--		86	55	--	.0		--	--		--	--	--	704	--
Apr. 22...........	19.2	39		40	17	41		153		76	38	--	1.5		343	.47		170	44	1.4	526	8.2
Oct. 8............	1.25	35		48	24	81		168		101	108	--	.8		526	.72		218	81	2.4	841	8.1
Jan. 13, 1953.....	9.26	36		42	21	48		146		101	50	--	1.8		397	.54		192	72	1.5	669	8.2
July 22...........	--	--		--	--	--		182		121	76	--	--		493	.67		244	95	--	761	8.2
Aug. 24...........	1.05	60		50	21	78		123		123	108	--	.5		536	.73		212	110	2.4	801	8.0
Apr. 26, 1956.....	2.36	34		47	21	69		151		121	74	--	.5		440	.60		204	80	2.1	716	8.2
May 19, 1960......	--	26		61	13	42		205		68	38	0.7	2.0		352	.48		206	38	1.3	557	7.9
June 2, 15, 23....	--	30		61	17	44		191		93	43	.8	1.2		405	.55		222	66	1.3	609	7.6
June 7, 9, 10.....	--	18		39	6.6	18		136		25	16	.5	3.5		196	.27		124	13	.7	311	7.7
July 3, 10........	--	--		--	--	--		172		--	62	--	--		--	--		224	83	--	691	7.7
July 6, 14, 20,27.	--	34		56	18	50		174		106	46	1.0	1.2		416	.57		214	71	1.5	615	7.6
Aug. 18...........	--	--		--	--	--		140		23	10	--	--		--	--		120	6	--	296	7.5
Aug. 24...........	--	--		--	--	--		158		107	54	--	--		--	--		198	68	--	638	7.9
Aug. 16, 1962.....	1.46	30		52	18	74		176		99	81	1.1	.2		442	.60		204	60	2.2	729	7.3
34. SALT FORK RED RIVER ABOVE SADDLERS CREEK NORTH OF LELIA LAKE																						
Feb. 13, 1951.....	11.7	24		74	28	118		207		156	158		1.5		719	0.98		300	130		1110	7.7
35. BARTON CREEK NORTHEAST OF CLARENDON																						
Mar. 22, 1959.....	b3	36		112	47	276		228		402	332		0.9		1320	1.80		473	286	5.5	2070	8.2

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
36. SADDLERS CREEK 8 MILES NORTHEAST OF CLARENDON																						
Feb. 13, 1951	5.0	28		82	36	145		240		216	174		1.0		858	1.17		352	156		1300	7.7
Mar. 21	6.0	28		93	43	189		218		282	246		.5		995	1.35		409	230		1650	8.0
37. SALT FORK RED RIVER NORTH OF LELIA LAKE																						
Mar. 21, 1951		24		81	32	184		202		221	240		0.5		871	1.18		334	168		1490	8.0
Mar 22, 1959	b2.0			64	26	126		216		150	147							266	89	3.4	1080	8.0
39. LELIA LAKE CREEK NEAR HEDLEY																						
June 13, 1950	3.0	--		95	27	57		198		221	54	--	5.5		666	0.91		348	186	--	890	--
Jan. 9, 1951	--	--		110	26	52		273		181	52	--	10		565	.77		382	158	--	894	--
Feb. 13	7.0	31		103	28	56		250		197	52	--	12		698	.95		372	167	--	921	7.6
Mar. 21	--	26		101	29	49		206		217	54	--	7.8		628	.85		371	202	--	933	8.0
Oct. 4, 1951	5.22	41		78	28	58		161		223	48	--	6.3		561	.76		310	178	1.4	858	7.9
Jan. 22, 1952	7.17	31		--	--	--		--		205	54	--	6.9		--	--		--	--	--	942	--
Apr. 22	11.1	46		60	30	74		108		237	66	--	6.0		599	.81		273	184	1.9	864	8.2
Oct. 8	5.58	44		73	28	54		143		215	48	--	7.7		601	.82		297	180	1.4	830	8.0
Jan. 13, 1953	5.79	40		66	28	52		105		217	51	--	9.2		542	.74		280	194	1.3	891	8.0
Aug. 12	8.22	50		51	17	32		170		89	23	--	3.2		372	.51		197	58	1.0	525	8.1
Nov. 24	6.82	38		--	--	59		--		225	53	--	9.2		--	--		--	--	--	961	--
Nov. 27, 1957	6.31	32		87	25	79		199		231	57	--	8.9		649	.88		320	157	1.9	956	7.9
Feb. 13, 1958	11.7	43		66	25	56	2.9	114		199	56	--	9.3		513	.70		268	174	1.5	806	8.2
Apr. 10, 1964	6.80	24		70	24	57		142		197	47	0.5	9.1		499	.68		273	156	1.5	767	7.5
June 21, 1967	.06	29		80	24	61	3.9	188		205	51	.7	2.2		549	--		298	144	1.5	822	7.7
41. WHITEFISH CREEK NEAR ALANREED																						
June 12, 1962							9.0	202		11	4.4	0.4	4.5		223			168	2	0.3	373	8.4
42. WHITEFISH CREEK SOUTH OF McLEAN																						
Mar. 21, 1951		26		269	83	178		182		869	245		0.8		1760	2.39		1010	864		2430	7.8
June 15, 1962						66		158		332	70		.6	0.19	784			430	300	1.4	1050	8.2
43. WHITEFISH CREEK NORTHEAST OF HEDLEY																						
Feb. 8, 1951	0.03	15		354	114	200		196		1210	260		0.0		2250	3.06		1320	1190		2820	8.1
Apr. 12, 1962						307		124		1360	440			0.37	3030			1470	1370		3590	8.1
44. GYP CREEK NORTH OF McKNIGHT																						
Jan. 1, 1951				824	304	3120		200		99	4950		2.3		12100	16.3		3310	3140		16500	
45. SALT FORK RED RIVER NORTH OF QUAIL																						
Mar. 22, 1959	b0.25			355	98	268		169		1240	315							1290	1150	3.2	3050	7.7
Apr. 21, 1963	b1.5	20		640	84	402		166		1800	570		2.0		3600	4.90		1940	1810	4.0	4320	7.2

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids (calculated): Tons per acre-foot	Dissolved solids (calculated): Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
								46. DOZIER CREEK NEAR WELLINGTON														
June 14, 1950.....	1.0	--		607	84	74		144		1720	75		6.8		2640	3.59		1860	1740	--	2820	--
Feb. 8, 1951......	--	14		585	84	84		186		1660	70		12		2600	3.54		1800	1650	--	2780	8.0
Mar. 5, 1953......	.23	24		584	82	65		110		1660	78		8.7		2560	3.48		1790	1700	0.7	2820	8.0
Sept. 18..........	.23	34		586	84	68		99		1690	76		9.0		2600	3.54		1810	1730	.7	2810	7.7
Nov. 25...........	.40	24		--	--	--		--		1640	73		9.3		--	--		--	--	--	2820	--
Jan. 12, 1955.....	.24	30		560	84	71		69		1660	75		8.0		2520	3.43		1740	1690	.7	2720	7.8
Jan. 15, 1960.....	--	--		--	--	--		58		--	38		--		--	--		608	560	--	1160	7.4
								48. NORTH FORK RED RIVER WEST OF KELLERVILLE														
Mar. 22, 1959.....	b6			208	112	335		149		156	1010							980	858	4.7	3560	7.9
								49. McCLELLAN CREEK AT STATE HIGHWAY 70 NEAR BOYDSTON														
Sept. 12, 1950....								86		8.0	2.9		5.0					74			170	7.9
								50 LAKE McCLELLAN NEAR JERICHO														
June 28, 1951.....		10	0.23	23	2.8	1.2	1.2	83		2.7	1.7	0.1	2.2	0.27	96			69	1		148	7.6
								51. McCLELLAN CREEK AT STATE HIGHWAY 273 NEAR McLEAN														
Jan. 6, 1965......	11.4	23		50	22	99		160		123	121	0.8	0.2		886	0.70		216	68	2.9	886	8.2
June 22...........	12.1	29		56	17	112		193		122	117	.8	.0		549	.75		210	52	3.4	929	7.4
Oct. 20...........	11.2	24		72	18	112		230		125	125	.8	.2		590	--		254	65	3.1	986	7.1
Nov. 22...........	10.9	24		66	19	105		216		118	120	.7	.2		559	--		244	67	2.9	961	7.4
June 8, 1966......	.1	24		65	21	121	4.6	183		123	175	.8	.0		624	--		248	98	3.3	1140	7.6
Jan. 17, 1967.....	2.07	25		78	20	124	3.0	249		133	141	.8	.0		647	--		277	73	3.2	1070	7.5
July 25...........	1.00	25		60	19	132	4.2	168		136	171	.9	.0		631	--		228	90	3.8	1060	7.9
Sept. 7...........	4.16	23		69	20	134	4.1	213		137	169	.8	.2		662	--		254	80	3.7	1100	7.6
								52. NORTH FORK RED RIVER NEAR SHAMROCK														
Feb. 26, 1951.....	162	22		148	35	172		200		268	315	--	1.5		1060	1.44		514	350	--	1750	7.5
Apr. 9............	12.0	32		194	47	207		168		489	340	--	1.5		1390	1.89		678	540	--	2130	8.4
July 25...........	2.19	28		248	22	28		113		593	41	--	2.5		1020	1.39		710	617	--	1310	7.8
Nov. 18...........	.73	26		392	57	117		107		1040	210	--	1.5		1900	2.58		1210	1120	1.5	2530	7.6
Jan. 21, 1952.....	18.5	21		--	--	--		--		428	308	--	1.5		--	--		--	--	--	1970	--
Dec. 8, 1953......	13.0	26		--	--	--		--		445	388	--	.2		--	--		--	--	--	2320	--
Jan. 9, 1958......	15.2	20		189	36	202		178		390	360	--	.5		1290	1.75		620	474	3.5	2050	7.5
Feb. 13...........	5.89	42		205	45	252		89		530	438	--	1.8		1560	2.12		696	624	4.1	2550	8.0
Mar. 22, 1959.....	b6.0	--		235	49	310		159		565	528	--	--		--	--		790	660	4.8	2740	8.0
May 27, 1964......	12.9	9.3		405	44	63		103		1080	84	0.5	.2		1740	2.37		1190	1110	.8	2010	6.5
May 28............	.13	14		430	55	152		128		1130	245	.6	1.0		2090	2.84		1300	1200	1.9	2590	6.5
May 29............	81.9	12		164	10	20		104		357	22	.3	5.3		642	.87		450	365	.4	889	7.1
June 14...........	2080	18		130	21	95		226		238	130	.6	.5		744	1.01		411	226	2.0	1170	6.8
Jan. 6, 1965......	18.3	7.5		218	54	218		76		584	402	.6	.5		1520	2.07		766	704	3.4	2260	8.1
Oct. 18...........	1180	14		122	20	155		141		186	292	.5	1.2		860	--		387	272	3.4	1510	6.8

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated) Milligrams per liter	Tons per acre-foot	Tons per day	Hardness as $CaCO_3$ Calcium, Magnesium	Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
52. NORTH FORK RED RIVER NEAR SHAMROCK--Continued																						
Nov. 22, 1965.....	10.8	19		265	47	202		146		618	375	0.7	1.2		1600	--		855	736	3.0	2470	7.1
July 24, 1966.....	35.6	13		295	21	24	8.3	168		661	40	.5	2.2		1150	--		822	685	.4	1480	7.1
Sept. 19..........	34.8	18		205	30	188	6.0	148		366	378	.6	2.2		1270	--		635	514	3.3	2070	6.9
Jan. 17, 1967.....	4.79	23		310	59	272	4.9	176		712	528	.5	2.2		2000	--		1020	872	3.7	2960	7.4
Apr. 14...........	28.4	18		227	46	293	7.1	180		416	580	.8	.5		1680	--		756	608	4.6	2710	7.0
June 28...........	92.0	11		172	19	60	5.2	142		364	109	.3	.5		811	--		507	390	1.2	1170	7.0
Aug. 5............	77.0	17		218	40	211	5.7	132		432	425	.6	2.2		1420	--		708	600	3.4	2200	7.5
Aug. 24...........	137	18		160	23	180	5.8	237		175	360	.6	1.2		1040	--		494	300	3.5	1750	7.1
53. SWEETWATER CREEK AT STATE HIGHWAY 152 WEST OF MOBEETIE																						
Feb. 13, 1951.....		17		74	13	17		298		14	10		2.0		294	0.40		238	0		499	7.7
Feb. 27...........	2.73	23		64	11	13		246		17	8		2.0		259	.35		205	3		410	8.1
54. SWEETWATER CREEK AT STATE HIGHWAY 152 SOUTHEAST OF MOBEETIE																						
Feb. 13, 1951.....		18		68	14	41		308		26	24		3.0		368	0.50		227	0		593	8.1
Feb. 27...........	8.84	27		68	14	20		280		17	16		2.0		302	.41		227	0		482	8.2
55. SWEETWATER CREEK NEAR WHEELER																						
Feb. 12, 1951.....	--	18		88	22	43		312		104	26		2.5		488	0.66		310	54	--	718	8.1
Feb. 13...........	--	19		79	19	34		348		27	24		2.0		402	.55		275	0	--	619	8.2
Feb. 27...........	29.3	27		81	22	50		336		79	29		3.8		458	.62		292	17	--	718	7.7
Feb. 27...........	39.2	27		77	21	55		340		75	28		2.0		457	.62		278	0	--	717	7.7
Feb. 27...........	78.5	31		70	18	39		334		25	23		1.5		372	.51		248	0	--	589	8.2
July 25...........	8.48	50		39	14	37		222		25	18		3.0		295	.40		155	0	--	448	8.1
Nov. 18...........	7.77	30		40	15	51		230		38	30		1.0		318	.43		162	0	1.7	560	8.0
Jan. 21, 1952.....	10.7	35		--	--	--		--		20	18		.8		--	--		--	--	--	506	--
Apr. 17...........	16.9	40		30	14	41		206		22	21		1.0		270	.37		132	0	1.6	426	8.2
Jan. 16, 1953.....	1.69	34		70	16	37		326		26	18		1.5		362	.49		240	0	1.0	586	8.1
May 11............	3.83	35		30	15	42		201		22	26		3.5		272	.37		137	0	1.5	435	8.2
Sept. 8...........	.08	58		36	14	32		210		21	16		.5		286	.39		147	0	1.2	423	8.2
Dec. 8............	5.91	36		--	--	29		--		20	19		1.0		--	--		--	--	--	506	--
Jan. 12, 1955.....	2.98	36		--	13	--		--		18	16		1.0		--	--		--	--	--	506	--
Apr. 24, 1957.....	13.5	32		104	12	33		391		29	21		--		423	.58		308	0	.8	--	--
Oct. 1............	.14	40		37	11	33		200		25	13		.5		258	.35		138	0	1.2	385	8.2
Jan. 9, 1958......	7.15	24		64	13	36		285		25	23		.5		326	.44		214	0	1.1	530	8.0
Feb. 13...........	6.14	42		--	15	42	2.9	--		28	24		1.2		--	--		--	--	--	526	--
56. SWEETWATER CREEK NEAR KELTON																						
Aug. 8, 1962......	11.9	28		104	21	61		267		202	32	0.7	1.8		598	0.81		346	127	1.4	860	7.0
Aug. 13, 1963.....	224	12		74	8.6	18		241		44	11	.2	.5		287	.39		220	22	.5	488	6.6
Nov. 19...........	10.8	25		83	18	46		287		100	28	.6	1.8		443	.60		281	46	1.2	709	7.4
Jan. 21, 1964.....	15.9	27		88	18	45		322		87	24	.7	1.8		450	.61		294	30	1.1	716	7.6
June 11...........	7.17	23		102	25	53		274		197	28	.7	3.0		567	.77		358	133	1.2	854	7.3

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated) Milligrams per liter	Dissolved solids (calculated) Tons per acre-foot	Dissolved solids (calculated) Tons per day	Hardness as $CaCO_3$ Calcium, Magnesium	Hardness as $CaCO_3$ Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
56. SWEETWATER CREEK NEAR KELTON--Continued																						
June 14, 1964	346	15		56	7.4	32		234		27	13	0.4	0.0		266	.36		170	0	1.1	455	6.8
Oct. 9	.17	30		175	46	90		196		528	78	.6	.2		1040	1.41		626	465	1.6	1430	7.4
Jan. 6, 1965	13.1	22		89	22	48		314		112	27	.8	3.0		478	.65		312	55	1.2	741	7.9
Oct. 18	389	14		44	5.4	25		178		22	12	.4	.5		211	--		132	0	.9	357	7.0
Nov. 23	15.2	25		91	19	52	2.9	318		121	32	.8	1.0		502	--		306	46	1.3	798	7.6
Mar. 8, 1966	17.1	22		96	19	51	2.3	300		127	31	.8	1.5		499	--		318	72	1.2	795	7.6
June 8	2.9	24		136	34	69	2.6	230		355	42	.5	2.0		778	--		480	291	1.4	1140	7.6
July 13	.2	30		166	47	99	3.0	180		554	71	.5	1.5		1060	--		608	460	1.7	1440	7.9
Aug 2	1.0	--		117	21	--		210		--	33	--	--		--	--		378	206	--	912	7.2
Sept. 12	.6	--		--	--	--		194		433	55	--	--		--	--		526	367	--	1250	7.4
Jan. 17, 1967	11.4	24		87	18	46	2.3	302		98	28	.7	1.0		454	--		291	44	1.2	715	7.5
Apr. 14	32.4	23		70	15	47	6.0	284		69	26	.9	.5		397	--		236	4	1.3	637	7.4
May 16	--	21		76	21	50	2.7	224		150	32	.8	1.8		465	--		276	92	1.3	720	7.9
Aug. 28	1.80	26		148	33	72	2.8	218		400	45	.7	2.5		837	--		505	326	1.4	1150	7.4
57. ELM CREEK NEAR SHAMROCK																						
Sept. 30, 1946	--	--		212	37	60		162		525	92	--	2.2		1010	--		681	--	--	1410	--
Oct. 26	2.54	--		169	29	100		241		403	98	--	5.0		923	--		541	--	--	1240	--
Oct. 26	1.01	--		--	--	--		277		305	82	--	9.0		--	--		--	--	--	1120	--
Oct. 26	.34	--		260	36	104		262		655	90	--	.0		1270	--		797	--	--	1620	--
Oct. 26	.91	--		139	31	57		306		230	70	--	11		743	--		474	--	--	1050	--
Oct. 26	2.51	--		--	--	--		194		471	98	--	2.8		--	--		--	--	--	1320	--
Nov. 25	--	--		178	31	70		260		352	94	--	14		998	--		572	--	--	1320	--
Dec. 16	2.32	--		156	28	73		196		359	90	--	4.0		864	--		504	--	--	1240	--
Feb. 13, 1947	2.42	--		173	35	54		242		343	95	--	3.8		908	--		576	--	--	1230	--
Apr. 8	--	--		161	28	81		248		342	92	--	5.0		891	--		517	--	--	1220	--
May 6	--	--		151	28	78		204		351	90	--	1.2		898	--		492	--	--	1240	--
June 12	3.3	--		181	31	38		264		310	83	--	7.4		853	--		579	--	--	1220	--
July 7	2.71	--		--	--	--		--		--	95	--	--		--	--		--	--	--	1210	--
Aug. 12	--	--		162	29	71		208		351	97	--	5.5		943	--		524	--	--	1250	--
Oct. 21	1.47	--		176	29	72		270		346	91	--	5.5		946	--		558	--	--	1270	--
Dec. 1	2.58	--		132	23	84		166		324	92	--	5.3		833	--		424	--	--	1270	--
June 10, 1950	3.0	--		152	29	89		269		328	89	--	6.5		948	1.29		498	278	--	1230	--
Sept. 1	1.97	31		142	28	86		166		365	98	--	3.5		886	1.20		470	334	--	1230	7.7
Sept. 28	2.67	40		121	29	78		106		355	93	--	4.5		815	1.11		421	334	--	1120	7.4
Oct. 17	2.39	38		124	33	62		96		354	92	--	4.2		801	1.09		445	366	--	1100	7.3
Mar. 15, 1951	2.17	40		139	34	41		111		337	91	--	6.1		787	1.07		487	396	--	1170	8.1
June 28	1.71	53		138	30	78		153		360	94	--	5.0		833	1.13		468	342	--	1240	7.7
May 11, 1953	1.67	34		129	32	73		102		373	97	--	5.0		866	1.18		454	370	1.5	1200	8.0
Sept. 8	1.35	60		--	--	--		90		308	121	--	1.5		--	--		360	--	--	1130	7.9
Dec. 8	1.93	26		--	--	--		--		377	98	--	3.0		--	--		--	--	--	1300	--
Jan. 12, 1955	1.67	39		131	28	78		76		393	98	--	2.5		863	1.17		442	380	1.6	1280	7.9
Jan. 9, 1958	1.41	23		197	25	89		248		425	100	--	1.5		982	1.34		594	391	1.6	1400	7.6
Mar. 22, 1959	b2.0	25		225	33	104		161		607	112	--	.2		1190	1.62		697	565	1.7	1580	7.9
Feb. 21, 1962	b4.0	--		194	28	73		274		370	103	0.5	3.6		998	--		600	376	1.3	1380	7.9
Aug. 8	3.04	25		166	27	93		224		380	102	.5	4.5		930	1.26		525	342	1.8	1280	7.0

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids (calculated): Tons per acre-foot	Dissolved solids (calculated): Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
58. ELM CREEK ABOVE WOLF CREEK NEAR LUTIE																						
Feb. 21, 1962	b10			472	66	78		156		1320	82		3.0		2250			1450	1320	0.9	2390	7.9
59. WOLF CREEK AT MOUTH NEAR LUTIE																						
Feb. 21, 1962	b5.0			596	96	57		164		1710	60	0.6	5.2		2780			1880	1750	0.6	2770	8.0
60. ELM CREEK BELOW WOLF CREEK NEAR LUTIE																						
Mar. 22, 1959	b4.0	13		528	85	94		115		1610	70		4.0		2460	3.35		1670	1570	1.0	2670	7.8
Feb. 21, 1962	b16			528	81	59		144		1490	74	0.6	3.9		2450			1650	1530	.6	2560	7.8
61. QUITAQUE CREEK NEAR QUITAQUE																						
Nov. 13, 1945	--	--		--	--	--		304		17	46		0.0		--	--		202	--		650	--
Nov. 13	--	--		--	--	--		302		18	50		.2		--	--		212	--		672	--
Nov. 14-20	4.6	--		32	39	66		276		43	51		.0		449	0.61		240	0		680	--
Nov. 21-30	4.72	--		28	36	67		304		42	50		.5		420	.57		218	0		717	--
Dec. 1-10	4.94	--		26	36	67		292		42	52		3.0		412	.56		213	0		681	--
Dec. 11-19	4.87	--		35	36	52		284		42	52		.0		429	.58		236	3		724	--
Dec. 21-31	4.85	44	0.05	40	36	62	8.0	330		42	49	3.6	.0		447	.61		248	0		719	8.7
Jan. 16, 1946	6.6	--		15	38	68		272		44	51		.5		403	.55		194	0		666	8.3
Feb. 15	6.3	--		27	38	79		294		57	67		.2		466	.63		224	0		778	8.3
Mar. 18	5.4	--		19	37	67		281		42	50		.2		404	.55		200	0		675	8.4
Apr. 15	5.6	--		18	37	70		287		42	50		.0		416	.57		197	0		681	8.4
May 15	4.5	--		23	38	69		299		42	52		.2		426	.58		214	0		702	8.5
June 15	3.2	--		29	40	81		337		45	63		.0		485	.66		237	0		800	8.3
July 15	3.6	--		20	39	98		314		50	78		4.0		491	.67		210	0		791	--
Aug. 15	2.8	--		40	35	65		314		40	60		.8		436	.59		244	0		747	--
Sept. 15	4.3	--		26	37	81		315		40	66		.8		442	.60		217	0		753	--
Oct. 12	--	--		37	16	42		214		20	34		5.6		298	.41		158	0		508	--
Oct. 15	--	--		37	35	67		312		40	60		.8		445	.61		236	0		751	--
Nov. 15	--	--		38	39	65		335		35	60		.2		452	.61		256	0		809	--
June 29, 1950	--	21		--	--	15		134		9.0	10		0		207	.28		100	0		245	7.7
July 5	--	22		31	14	29		177		18	23		2.0		238	.32		135	0		389	7.9
July 23	--	14		27	4.9	7.5		107		7.7	4.0		3.0		129	.18		88	0		199	7.8
July 28	18.1	32		--	--	35		185		18	24		.0		264	.36		128	0		398	8.5
Mar. 17, 1951	6.08	58		35	38	51		292		42	50		1.5		420	.57		244	4		761	8.6
62. ROARING SPRINGS NEAR ROARING SPRINGS																						
Dec. 1937	--	--		76	28	59		325		51	69	1.2	15		459	--		305	--	--	--	--
May 16, 1952	1.80	68		--	--	83		--		78	97	--	23		498	0.68		170	57	2.8	749	8.1
June 10, 1953	1.47	44		77	31	73		294		77	95	--	28		570	.78		320	78	1.8	960	7.9
Jan. 20, 1954	1.34	43		--	--	--		--		76	95	--	9.2		--	--		--	--	--	948	--
Jan. 18, 1955	1.51	49		--	31	--		--		77	96	--	26		--	--		--	--	--	966	--
Jan. 19, 1956	1.54	38		78	29	75		303		76	92	--	25		580	.79		314	66	1.8	956	8.2
Jan. 28, 1958	1.34	64		--	28	79	8.0	--		74	85	--	28		--	--		--	--	--	869	--
Apr. 16	1.57	--		--	--	--		180		--	73	--	--		--	--		205	58	--	919	8.2
Mar. 20, 1959	bl.5	--		82	27	66		318		75	85	--	--		--	--		316	56	1.6	956	7.7
June 18	1.26	--		--	--	79	8.2	--		76	84	--	--		--	--		--	--	--	853	--
May 20, 1960	--	34		79	30	74		315		77	83	1.4	29		577	.78		320	62	1.8	933	7.1
June 22	1.16	--		--	--	--		--		--	87	--	--		--	--		--	--	--	707	--
Sept. 21	.85	--		--	--	--		--		78	88	--	--		--	--		--	--	--	--	--
Aug. 9, 1962	1.28	34		81	28	75		317		75	79	1.3	32		561	.76		317	57	1.8	900	7.4

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
63. MIDDLE PEASE RIVER NEAR PADUCAH																						
Sept. 11, 1950....	b200	22		177	27	106		109		458	152		3.0		999	1.36		552	463		1460	7.4
Feb. 11, 1959.....	b1.0	--		1320	217	11100		125		3730	17300							4180	4080		44300	8.0
64. SALT SPRINGS TRIBUTARY TO MIDDLE PEASE RIVER 14 MILES NORTHEAST OF PADUCAH																						
Feb. 11, 1959.....	b0.02			1430	243	13900		111		4100	21700							4570	4480		52000	7.9
Mar. 21...........				1080	241	6540		170		3210	10200							3700	3560		28900	7.4
65. PEASE RIVER NEAR CHILDRESS																						
Mar. 21, 1959.....	--	--		1200	246	7620		151		3270	12100				--			4000	3880		32600	7.8
Jan. 26, 1967.....	2.57	10		1260	229	8040	18	144		3330	12700				25600			4090	3980		36600	7.4
Aug. 24...........	1.83	11		1040	180	5700	18	124		2190	9300				18500			3340	3240		28200	7.3
Sept. 15.....	6.54	10		705	115	4110	15	108		1730	6600				13500			2250	2160		20500	6.9
67. PEASE RIVER NEAR VERNON																						
July 16, 1942.....	--	--		580	115	1080		126		1820	1610		6.7		5270			1920	--	--	7570	--
Apr. 10, 1951.....	--	--		500	139	1610		165		1540	2540		.5		6410	8.72		1820	1680	--	10100	--
Jan. 27, 1967.....	0.35	5.5		478	132	1360	7.3	235		1560	2050		--		5710			1740	1540	14	8440	7.3
Apr. 17...........	67.9	9.9		385	50	782	7.9	125		944	1240		.8		3480			1170	1060	9.9	5310	7.0
Aug. 24...........	30.6	9.1		405	41	1050	9.5	77		1070	1640		2.0		4260			1180	1120	13	6520	7.2
69. NORTH WICHITA RIVER 11 MILES SOUTH OF PADUCAH																						
Nov. 28, 1951.....	13.9	18		767	180	4060		156		2230	6410				13700	18.6		2650	2530		20500	7.7
Mar. 12, 1952.....	11.3	10		821	194	4380		150		2300	6990				14800	20.1		2850	2720		22100	7.7
Jan. 13, 1953.....	--	21		797	191	4730		95		2410	7430				15600	21.2		2770	2700		22900	7.9
Feb. 10, 1954.....	10.2	--		--	--	4820		128		2460	7660				24000	--		--	--		24000	7.8
70. NORTH WICHITA RIVER 10 MILES SOUTHEAST OF PADUCAH																						
July 25, 1951.....	5.4	23		599	145	1870		112		1860	2920		--		7470	10.2		2090	2000	--	11400	7.8
Nov. 28...........	4.45	22		540	134	879		138		1590	1440		13		4690	6.38		1900	1790	8.8	6790	7.6
Mar. 12, 1952.....	4.17	16		661	145	2190		183		1890	3460		--		8450	11.5		2240	2100	2.0	12800	7.7
Jan. 13, 1953.....	3.04	18		514	133	775		90		1600	1250		16		4350	5.92		1830	1760	7.9	6100	7.9
Feb. 10, 1954.....	3.53	--		--	--	3080		110		2110	4930		--		--	--		--	--	--	16800	7.8
Nov. 21, 1956.....	.60	27		1260	265	11900		117		3870	18500		--		35900	47.7		4230	4140	--	44600	7.9
July 30, 1958.....	--	--		--	--	--		128		--	1980		--		--	--		1280	1180	--	7660	7.9
Dec. 22, 1966.....	6.40	6.6		920	185	5720	22	188		2740	9050		--		18700	--		3060	2960	--	27200	7.4
June 12, 1967.....	c1200	8.9		53	7.3	73	5.4	96		84	11	0.6	4.2		394	--		162	84	2.5	692	7.5
Aug. 24...........	4.35	4.8		660	129	3690	14	126		1880	5800		--		12300	--		2180	2070	--	18700	7.4
71. SALT CREEK 4 MILES SOUTHEAST OF PADUCAH																						
Nov. 28, 1951.....		18		1290	304	12300		126		3850	19100				37000			4460	4360		48000	7.6
Mar. 21, 1952.....	0.5	15		475	120	2140		177		1330	3410				7580			1680	1530		12200	7.7
July 30, 1958.....		21		1240	285	12100		125		3890	18400				36000			4260	4160		45700	7.4
July 30...........		--		--	--	--		129		--	19700				--			4400	4290		48800	7.7

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
72. SALT CREEK AT MOUTH 8 MILES SOUTHEAST OF PADUCAH																						
Nov. 16, 1939.....	--	--		546	124	393		186		1590	650		5.6		3400	--		1870	--		--	--
July 25, 1951.....	2.7	9.1		1010	271	8230		51		3030	13000		--		25600	34.3		3640	3600	--	36700	8.2
Nov. 28...........	2.27	9.0		1230	299	11200		95		3630	17600		--		34000	--		4290	4210	--	45000	7.5
Mar. 12, 1952.....	2.22	7.2		1320	319	11800		87		3730	18600		--		35800	47.6		4600	4530	75	47000	7.8
Jan. 13, 1953.....	1.96	14		1270	297	11700		91		3800	18200		--		35300	46.9		4390	4310		47000	7.8
Feb. 10, 1954.....	2.31	--		--	--	11600		91		3890	18800		--		--	--		--	--	--	48500	7.8
Nov. 21, 1956.....	1.04	14		1200	272	11700	--	94		3820	18300		--		35300	46.9		4110	4030	--	44000	7.8
July 30, 1958.....	--	--		--	--	--		57		--	7240		--		--	--		1730	1680	--	21400	7.9
July 30...........	--	13		92	15	332		92		196	520		1.0		1210	1.65		291	216	8.5	2190	7.6
Mar. 18, 1959.....	--	--		1300	270	12400		119		4050	19200		--		--	--		4360	4260	--	47300	7.6
73. NORTH WICHITA RIVER BELOW SALT CREEK 12 MILES SOUTHEAST OF PADUCAH																						
Mar. 12, 1952.....	5.89	11		871	209	5320		138		2490	8440				17400	23.7		3030	2920	42	25900	7.7
July 30, 1958.....								108			4490							1580	1490		14300	7.9
74. NORTH WICHITA RIVER NEAR PADUCAH																						
July 30, 1958.....	--	10		444	94	2310		106		1310	3590				7810	10.6		1490	1410	26	12200	7.6
Mar. 18, 1959.....	--	--		851	121	5300		154		2610	8020				--			2620	2490	45	23800	7.8
Dec. 7, 1965......	4.8	5.0		960	220	6130		164		2720	9680				19800			3300	3170	--	29700	7.1
May 31, 1966......	2.8	1.2		1040	231	6720	15	95		3100	10700				21900			3560	3470	--	30200	6.8
July 5............	2.2	.8		975	207	6300	23	72		2970	9800				20300			3290	3220	--	29200	6.6
75. NORTH WICHITA RIVER NEAR TRUSCOTT																						
Feb. 10, 1954.....	13.7	--		--	--	3860		128		2590	6360				--			--	--	--	20800	7.9
Nov. 21, 1956.....	7.0	8.4		941	216	4470		116		2820	7050				15600	21.2		3240	3140	34	21700	8.0
Mar. 19, 1959.....	--	--		911	218	4460		114		2890	6930				--			3170	3080	34	21500	7.8
Dec. 7, 1965......	11.7	2.7		853	231	3480		147		2480	5630				12700			3080	2960	--	19700	7.3
June 1, 1966......	4.1	3.8		961	226	4060	43	145		2770	6620				14800			3330	3210	--	23100	7.0
July 6............	1.9	6.5		774	167	2860	20	142		2190	4480				10600			2620	2500	--	15400	7.2
Sept. 16..........	c2740	8.4		130	11	58	4.0	154		245	79	0.2	3.0		615			370	244	1.3	955	7.0
Dec. 21...........	14.5	3.4		830	192	3470	18	160		2580	5500				12700			2860	2730	--	18400	7.5
Aug. 23, 1967.....	11.8	2.8		910	190	3440	16	93		2750	5370				12800			3060	2980	--	18500	7.4
76. SOUTH WICHITA RIVER AT GUTHRIE																						
Sept. 11, 1950....	5	23		228	64	377		103		686	605		1.0		2040	2.77		832	748	--	3140	7.8
July 30, 1958.....	--	8.8		570	227	1450		103		2020	2350				6680	9.08		2360	2270	13	9530	7.5
Mar. 19, 1959.....	b.04	--		759	296	1860		125		2720	2990				--	--		3110	3010	14	11700	7.5
Apr. 20, 1963.....	b.25	3.4		675	260	1540		166		2470	2400				7430	10.1		2750	2620	13	9880	7.2
78. SOUTH WICHITA RIVER 6.5 MILES EAST OF GUTHRIE																						
Jan. 13, 1953.....	4.23	16		1210	305	8810		117		3090	14300				27800	37.1		4280	4180		38500	7.8
Feb. 10, 1954.....	5.19	--		--	--	8000	--	116		3000	13300				--	--		--	--		36800	7.8
Nov. 21, 1956.....	--	22		1190	294	8870	--	113		3140	14400				27900	37.3		4180	4090		36800	7.9
July 30, 1958.....	--	15		833	178	4830		121		2220	7730				15900	21.6		2810	2710		23000	7.5
Mar. 19, 1959.....	--	--		1240	269	9530		131		3290	15200				--	--		4200	4090		39200	8.0

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids (calculated): Tons per acre-foot	Dissolved solids (calculated): Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
79. SOUTH WICHITA RIVER NEAR BENJAMIN																						
July 29, 1949	10	--		--	--	--		--		--	6080		--		--	--		--	--	--	20100	--
Jan. 13, 1953	4.0	24		1420	394	8890		110		3410	14800		--		28900	38.6		5160	5060	--	39900	7.8
Feb. 10, 1954	5.90	--		--	--	6620		106		3040	11300		--		--	--		--	--	--	32200	7.7
Nov. 21, 1956	1.65	8.7		1250	303	6330	--	118		3000	10700		--		21700	29.1		4360	4260	41	28900	8.0
Mar. 19, 1959	--	--		1420	394	8330		136		3750	13600		--		--	--		5150	5040	50	36300	8.1
Dec. 7, 1965	10.2	5.0		1030	289	4490		182		2690	7500		--		16100	--		3760	3610	--	24300	7.2
June 1, 1966	1.7	5.7		1360	396	6320	68	172		3600	10600		--		22500	--		5020	4880	--	33500	7.3
July 6	.4	8.3		999	193	2840	21	133		2310	4820		--		11300	--		3290	3180	--	16700	7.2
Sept. 16	c3710	6.7		250	18	184	5.1	104		546	305	0.2	0.2		1370	--		698	613	3.0	2070	6.8
Jan. 25, 1967	8.78	2.1		1050	275	4920	22	177		2940	7900		--		17200	--		3750	3610	--	24700	7.4
June 13	26.0	8.8		480	62	605	10	88		1170	1060		1.5		3440	--		1450	1380	6.6	5010	7.0
Aug. 23	4.48	6.6		1140	279	4320	22	154		3070	7140		--		16100	--		3990	3860	--	23300	7.5
80. WICHITA RIVER NEAR SEYMOUR																						
Jan. 13, 1953	8.0	18		792	207	3550		85		2320	5710	--	--		12600	17.1		2830	2760	--	18400	7.8
Feb. 10, 1954	17.6	--		--	--	3490	--	102		2240	5860	--	--		--	--		--	--	--	19100	7.8
July 30, 1958	--	14		500	88	1230		75		1190	2120	--	--		5180	7.04		1610	1550	13	8020	7.4
Dec. 7, 1965	44.8	5.7		799	216	2920		167		2030	4950	--	--		11000	--		2880	2740	--	17000	7.2
July 7, 1966	8.5	9.3		540	127	1830	13	140		1470	2920	--	--		6980	-		1870	1760	18	10500	7.6
Sept. 1	2310	10		170	17	112	4.8	129		370	173	0.3	0.5		921	--		921	388	2.2	1430	7.0
Dec. 20	--	6.3		815	212	3150	18	166		2320	5150	--	--		11800	--		2900	2770	--	17100	7.3
June 14, 1967	906	9.8		146	18	140	5.7	110		362	200	.5	.5		936	--		438	348	2.9	460	7.1
Aug. 23	21.2	9.3		568	125	1760	11	127		1520	2900	--	--		6950	--		1930	1820	--	10500	7.6
81. LAKE KEMP NEAR MABELLE																						
Oct. 10, 1939		7.2	--	212	44	435		86		594	685	0.3	0.0	--	2020	--		710	--	--	--	--
July 15, 1942		--	--	198	44	383		116		529	610	--	3.0	--	1824	--		675	--	--	2970	--
June 6, 1946		7.0	0.09	282	65	762	22	104		774	1250	.6	.8	--	3210	--		972	--	--	5230	7.5
June 16, 1952		7.4	.02	240	57	694		106		675	1100	.4	.0	--	2830	3.85		834	746	10	4650	7.4
June 15, 1954		4.7	.02	140	28	324	5.6	78		373	520	.4	.5	0.31	1430	1.94		464	400	6.5	2430	7.2
Nov. 23, 1955		6.5	.06	146	25	298	6.1	86		387	470	.3	.8	.39	1380	1.88		468	397	6.0	2290	7.6
Oct. 23, 1964		6.7	--	248	61	794		106		716	1250	--	1.5	--	3130	4.26		870	783	12	4910	6.8
June 30, 1965		6.4	--	225	54	714		116		648	1110	--	1.5	--	2820	3.84		784	688	11	4660	6.7
Aug. 31		6.6	--	225	52	709		88		652	1110	--	1.5	--	2800	3.81		776	704	11	4650	6.5
Dec. 7		7.3	--	270	60	740		132		740	1170	--	.5	--	3050	--		920	812	11	4890	6.8
Jan. 23, 1967		5.7	--	210	42	518	6.2	102		560	820	--	1.2	--	2210	--		696	613	8.5	3620	7.3
82. WICHITA RIVER NEAR MABELLE																						
Dec. 12, 1965	128	6.1		220	46	573		95		616	898		0.0		2410			740	662	9.2	3920	6.8
June 1, 1966	12.0	7.3		603	162	1980	11	135		1670	3340		--		7850			2170	2060	--	12300	7.1
June 2	328	5.4		245	49	656	6.9	109		640	1080		.5		2740			813	724	10	4550	7.0
July 7	461	5.6		250	52	694	7.0	109		672	1110		1.5		2850			838	748	10	4650	7.2
Oct. 11	1740	6.3		189	35	460	6.0	86		512	720		1.2		1970			616	545	8.0	3250	6.9
Dec. 20	150	6.8		213	42	526	5.9	103		562	830		1.0		2240			704	620	8.6	3690	7.0
July 21, 1967	1340	6.0		208	40	512	5.9	108		556	810		1.8		2190			684	595	8.5	3540	7.3
Aug. 22	399	6.2		204	39	477	6.0	110		534	760		1.2		2080			670	580	8.0	3280	7.2

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids (calculated): Tons per acre-foot	Dissolved solids (calculated): Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
83. SANTA ROSA LAKE NEAR VERNON																						
May 5, 1966.......		6.0		34	7.2	12	3.8	138		22	5.3	0.2	0.8		159			114	1	0.5	281	7.4
Nov. 21...........		9.5		32	7.2	11	4.3	130		19	7.7	.1	.2		155			109	3	.5	265	6.9
84. BEAVER CREEK NEAR ELECTRA																						
Apr. 26, 1966.....	103	7.8		50	12	128	2.9	132		11	243	0.3	2.2		522			174	66	4.2	1020	7.2
June 2............	.7	--		--	--	--	--	90		--	1500				--			700	626	--	4760	7.0
Dec. 27...........	2.10	7.2		290	135	935	7.0	206		54	2200				3730			1280	1110	11	6830	7.5
Jan. 27, 1967.....	3.2	5.0		330	168	1170	7.2	200		38	2750				4560			1510	1350	13	8120	7.7
Feb. 28...........	.39	1.0		330	156	1110	7.4	218		85	2600				4400			1460	1290	13	7740	7.5
85. NORTH BUFFALO CREEK NEAR IOWA PARK																						
Nov. 3, 1961......	0.15	7.9		160	50	722		67		57	1460	0.3	0.0		2490	3.39		604	550	13	4660	6.3
June 19, 1962.....	309	7.3		20	6.0	32		54		8.4	64	.2	1.5		166	.23		75	30	1.6	324	6.0
June 19...........	167	9.6		21	6.0	30		68		9.8	52	.3	1.5		163	.22		77	21	1.5	309	6.0
Sept. 19..........	2.13	12		20	6.0	27		91		12	31	.3	.8		163	.22		75	0	1.4	271	6.2
May 6, 1963.......	.95	5.3		425	147	1870	6.6	43		137	3900	--	--		6510	8.85		1660	1630	20	10900	5.9
86. BUFFALO CREEK NEAR IOWA PARK																						
Feb. 12, 1964.....	0.16	6.4		48	18	188		88		23	355	0.3	6.2		688	0.94		194	122	5.9	1340	7.1
May 4.............	.01	8.4		93	33	313		139		40	632	.3	.8		1190	1.62		368	254	7.1	2270	6.8
June 3............	1.14	9.9		36	12	85		110		14	155	.2	1.2		367	.50		140	50	3.1	711	7.0
Sept. 23..........	39.1	7.5		41	13	111		120		15	199	.3	2.5		448	.61		156	58	3.6	866	6.7
Jan. 26, 1965.....	.36	7.7		96	73	410		324		110	740	.7	6.8		1600	2.18		540	274	7.7	2840	7.1
June 23...........	.30	9.4		68	30	221		164		30	430	.3	1.8		872	1.19		293	158	5.6	1680	6.6
Apr. 12, 1967.....	1000	5.8		18	5.0	35	4.8	37		31	56	.2	3.0		177	--		65	35	1.9	331	6.6
87. WICHITA RIVER AT WICHITA FALLS																						
Oct. 12, 1951.....	354	12		230	61	614		113		629	1000		2.0		2600	3.54		825	732	9.3	4320	7.4
Oct. 14, 1966.....	1550	6.5		195	40	480	6.4	102		514	770		1.5		2060			651	568	8.2	3480	6.8
88. LAKE WICHITA AT WICHITA FALLS																						
Oct. 19, 1944.....		3.0	0.10	152	41	407		74		264	775	0.9	1.0	--	1680	--		548	--	--	3240	7.5
Nov. 16...........		2.0	.25	172	41	424		66		294	820	.9	1.5	--	1790	--		598	--	--	3370	7.7
June 6, 1946......		4.0	.67	81	25	280	21	80		101	545	.6	.8	--	1100	--		305	240	--	2070	7.0
Mar. 24, 1952.....		8.6	.03	120	36	304	.8	104		239	552	.2	1.5	0.35	1310	1.78		448	362	6.2	2440	7.4
June 15, 1954.....		6.6	.37	34	8.8	66	5.7	104		36	109	.5	.2	.04	336	.43		121	36	2.6	592	7.2
Mar. 11, 1959.....		5.0	--	101	24	259		118		175	450	.3	.4	--	1070	1.46		350	254	6.0	1890	7.6
June 23, 1965.....		8.2	--	120	33	363		134		270	590	.4	1.0	--	1450	1.97		435	325	7.6	2570	6.6
89. WICHITA RIVER AT FARM ROAD 171 NEAR BYERS																						
July 21, 1949.....		10		200	77	615		146		486	1080		3.5	1.15	2540	3.45		816	696		4350	8.0
Dec. 12, 1951.....				248	84	670		226		573	1160		4.4		2850	3.88		964	780	9.4	4720	7.5
July 29, 1958.....				--	--	--		116		--	610		--		--	--		545	450		2750	7.8

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
90. LAKE KICKAPOO NEAR ARCHER CITY																						
Oct. 21, 1946....		8.2	0.25	16	4.4	17	4.1	90		4.8	14	0.4	1.8	--	115	--		58	0	--	214	7.0
Feb. 20, 1952.....		4.3	.00	33	11	25	.8	176		8.4	18	.5	.5	0.07	197	0.27		128	0	1.0	335	7.9
June 15, 1954.....		3.1	.04	24	8.4	23	--	139		7.7	15	.5	2.8	.00	153	.21		94	0	1.0	274	7.6
Jan. 23, 1957.....		4.0	.07	32	9.8	33		188		9.8	19	.4	.2	--	209	.27		120	0	1.3	389	8.2
Oct. 23, 1964.....		5.7	--	28	9.3	36		159		11	31	.4	.2	--	200	.27		108	0	1.5	371	7.2
June 23, 1965.....		5.2	--	26	8.8	39		151		13	33	.4	.2	--	200	.27		101	0	1.7	379	6.9
Aug. 30...........		9.0	--	34	9.0	44		181		13	38	.4	.2	--	237	.32		122	0	1.7	432	7.1
Dec. 7............		9.4	--	30	10	45		176		14	38	.4	.0	--	234	--		116	0	1.8	421	7.3
Jan. 27, 1967.....		4.5	--	29	8.0	32	4.5	153		10	30	.3	.2	--	194	--		105	0	1.4	356	7.5
May 10............		5.0	--	31	8.0	33	4.5	162		10	32	.6	.5	--	205	--		110	0	1.4	370	8.0
92. LAKE CREEK NEAR HENRIETTA																						
Apr. 18, 1959.....	b5	9.0		69	19	363		88		34	660	0.7	0.2		1200	1.63		250	178	10	2220	7.2
Apr. 21...........	b.5	14		77	20	503		110		46	870	.8	.8		1590	2.16		274	184	13	2920	8.1
94. DRY FORK LITTLE WICHITA RIVER NEAR HENRIETTA																						
Oct. 4, 1959......		12		9.1	1.8	7.8		44		0.8	6.5	0.1	0.8		61	0.08		30	0	0.6	87	7.6
Oct. 7............		18		16	3.7	18		78		5.8	16	.1	1.0		117	.16		54	0	1.1	182	7.6
95. EAST FORK LITTLE WICHITA RIVER NEAR HENRIETTA																						
Oct. 4, 1959......	--	11		6.5	1.9	8.9		34		0.8	10	0.0	0.8		57	0.08		24	0	0.8	85	7.3
Oct. 7............	--	16		14	3.4	18		66		3.2	22	.2	.5		109	.15		50	0	1.1	176	8.1
Mar. 10, 1964.....	0.22	13		22	5.1	23		104		10	20	.3	.8		145	.20		76	0	1.1	258	6.7
Apr. 28...........	11.2	12		14	3.9	14		60		6.8	16	.2	2.0		99	.13		51	2	.9	181	6.2
Apr. 30...........	1.88	12		16	4.9	16		72		9.2	17	.1	1.5		112	.15		60	1	.9	206	6.3
May 8.............	302	7.7		15	3.5	26		40		4.8	49	.0	2.8		129	.18		52	19	1.6	257	6.0
May 28, 1965......	641	8.9		10	2.9	15		43		6.2	19	.1	.5		84	.11		37	2	1.1	146	6.5
June 22...........	.10	13		24	6.8	24		109		12	26	.2	.5		160	.22		88	0	1.1	288	6.6
Aug. 25...........	.32	9.9		12	3.9	12		64		5.8	7.9	.3	.8		84	.11		46	0	.8	141	6.5
Apr. 24, 1966.....	909	5.1		5.0	2.2	3.7	4.5	22		6.6	2.7	.2	.5		42	--		22	4	.3	66	6.1
Apr. 27...........	--	10		11	3.7	10	5.3	46		5.0	14	.3	.5		83	--		43	5	.7	145	6.7
Apr. 30...........	2730	6.8		6.5	2.2	4.8	3.9	28		1.8	6.9	.2	.2		47	--		25	2	.4	91	6.2
May 3.............	54.0	12		24	6.0	26	4.2	82		10	48	.1	.2		170	--		85	17	1.2	313	7.6
May 18............	.5	14		62	19	80	6.2	215		27	150	.3	.5		465	--		232	56	2.3	862	7.2
May 31, 1967......	564	8.6		7.5	3.1	6.7	6.0	35		4.4	9.6	.5	2.5		66	--		31	3	.5	105	6.3
98. FARMERS CREEK RESERVOIR NEAR NOCONA																						
Apr. 12, 1967.....		3.4		50	13	38	6.3	164		28	74	0.5	0.2		294	--		178	44	1.2	552	7.3
100. WASHITA RIVER AT FARM ROAD 2564 NEAR ALLISON																						
June 16, 1965.....	15.0	35		17	19	45		307		61	35	0.7	1.2		425	0.58		270	18	1.2	686	7.9
Sept. 6...........	.64	31		89	20	55		332		86	43	.7	.2		488	.66		304	32	1.4	786	7.5
June 7, 1966......	.4	--		65	23	--		256		--	49	--	--		--	--		256	46	--	736	7.6
Jan. 17, 1967.....	.65	21		76	20	41	2.6	273		85	35	.5	.0		415	--		272	48	1.1	668	7.6
June 21...........	.61	25		80	23	56	3.5	328		81	45	.8	.2		476	--		294	25	1.4	755	7.8
Sept. 7...........	.58	30		76	24	61	3.9	300		103	50	.8	.2		497	--		288	42	1.6	770	8.2

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated): Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
103. BOIS D'ARC CREEK NEAR RANDOLPH																						
Nov. 30, 1965	1.1	8.2		72	2.7	41	3.2	268		27	23	0.5	0.2		310			190	0	1.3	580	7.5
Mar. 30, 1966	6.1	2.9		36	2.8	24	1.5	109		41	16	.5	.0		179			101	12	1.0	351	7.9
Feb. 22, 1967	2.66	1.9		62	3.1	56	2.5	254		46	24	.3	.2		321			168	0	1.9	550	7.4
Apr. 4	5.70	4.4		70	2.9	18	2.1	210		35	11	.6	.0		247			187	14	.6	431	7.2
May 1	39.0	10		81	2.5	20	2.6	247		32	12	.7	5.0		287			212	10	.6	486	7.2
July 12	.45	5.6		53	3.1	36	2.4	174		44	24	.6	.2		255			145	2	1.3	438	7.3
Sept. 6	4660	9.2		70	1.0	3.0	2.4	218		5.0	1.6	.4	.8		200			179	0	.1	344	7.2
104. SANDERS CREEK NEAR CHICOTA																						
Nov. 29, 1961	3.9	7.5		30	2.4	8.1	3.4	90		22	5.5	0.3	1.0		124	0.17		85	11	0.4	218	6.3
Feb. 6, 1962	9.1	14		73	6.3	29		178		82	28	.2	.0		334	.45		208	62	.9	515	7.0
Apr. 22	1.4	13		84	7.7	42		201		104	42	.3	.0		398	.54		241	76	1.2	591	7.9
May 25	.5	11		97	7.6	38		254		93	36	.3	.0		422	.57		274	66	1.0	679	7.1
Nov. 29, 1965	.1	17		80	23	73	10	254		77	127	.3	.2		532	--		296	88	1.8	948	7.4
Mar. 14, 1966	6.2	15		33	6.6	23	2.8	65		46	39	.3	.2		198	--		110	56	1.0	351	6.5
June 13	2.0	13		66	11	42	3.9	193		58	64	.2	.0		353	--		210	52	1.3	632	7.8
Feb. 25, 1967	.23	17		72	23	72	9.5	244		91	110	.2	.5		515	--		274	74	1.9	877	7.4
Apr. 7	9.71	8.6		34	5.3	17	3.7	102		32	20	.4	.5		172	--		107	23	.7	300	6.7
June 6	464	7.8		22	2.7	5.0	3.2	73		11	4.9	.2	1.8		95	--		66	6	.3	156	7.6
July 11	390	5.1		22	2.3	4.7	3.1	73		9.2	4.5	.4	2.0		89	--		64	5	.3	148	7.6
105. RED RIVER AT ARTHUR CITY																						
Nov. 1, 1961	2560			114	51	222		176		258	400		2.0		1220	1.66	8430	495	350	4.3	1980	8.3
Dec. 13	16100			42	10	69		86		75	106		.1		374	.51	16260	148	78	2.5	605	8.0
Jan. 4, 1962	3540			81	34	188		134		192	310		1.1		980	1.33	9370	340	230	4.4	1550	8.3
Feb. 2	5000			98	26	198		144		218	310		.6		1020	1.39	13770	352	234	4.6	1580	8.1
Mar. 1	c4820			62	18	105		120		128	160		.2		608	.83	7910	228	130	3.0	979	8.2
Apr. 2	13800			36	6.8	33		108		43	38		2.3		253	.34	9430	118	30	1.3	372	8.0
May 2	7180			50	10	45		144		60	59		1.3		351	.48	6800	166	48	1.5	540	8.1
June 19	32400			109	30	237		138		262	372		.2		1180	1.60	103200	395	282	5.2	1850	8.0
Aug. 15	4820			105	32	210		158		238	335		1.0		1100	1.50	14320	395	266	4.6	1730	8.2
Sept. 11	10800			36	4.4	30		108		32	35		1.1		226	.31	6590	108	20	1.2	355	8.0
Oct. 10	4650			94	31	193		136		225	308		.0		1010	1.37	12680	360	248	4.4	1590	7.7
Nov. 6	4140			--	--	175		146		--	--		--		848	1.15	9480	320	200	4.2	1350	8.4
Dec. 4	24200			--	--	143		120		125	215		--		566	.77	36980	222	124	4.2	936	8.2
Jan. 29, 1963	4820			--	--	187		154		210	295		--		936	1.27	12180	355	229	4.3	1510	8.0
Feb. 26	689			--	--	116		236		122	175		--		657	.89	1220	315	121	2.8	1100	8.2
Mar. 26	5580			--	--	39		124		56	70		--		314	.43	4730	174	72	1.3	513	8.2
Apr. 23	1640			--	--	125		122		140	182		--		682	.93	3020	230	130	3.6	1040	8.3
May 21	1640			--	--	175		128		195	260		--		945	1.28	4180	295	190	4.4	1390	8.4
June 18	1560			--	--	191		152		215	290		--		974	1.32	4100	340	219	4.5	1500	8.3
July 16	1780			--	--	123		156		128	182		--		642	.87	3080	250	122	3.4	1050	8.4
Aug. 12	2340			--	--	210		140		225	322		--		1050	1.43	6630	345	230	4.9	1610	8.2
Sept. 9	2180			--	--	235		144		246	370		--		1130	1.54	6650	386	268	5.2	1790	8.4
106. LAKE CROOK NEAR PARIS																						
Mar. 18, 1960		3.2		14	1.3	6.3	2.9	35		19	6.0	0.3	0.2		70	0.10		40	12	0.4	118	6.7

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated) Milligrams per liter	Dissolved solids (calculated) Tons per acre-foot	Dissolved solids (calculated) Tons per day	Hardness as $CaCO_3$ Calcium, Magnesium	Hardness as $CaCO_3$ Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
107. BIG PINE CREEK NEAR MANCHESTER																						
May 25, 1962.....	2.0	13		23	5.3	20		70		36	20	0.2	0.0		158	0.21		79	22	1.0	255	6.7
Apr. 21.........	23.9	9.6		20	4.4	18		42		47	17	.2	.0		150	.20		68	34	.9	218	6.8
Mar. 27, 1963....	500	5.8		10	2.5	8.1	2.8	20		25	10	.1	.5		75	.10		35	19	.6	122	6.1
108. PECAN BAYOU NEAR CLARKSVILLE																						
Jan. 17, 1967....	0.2	6.1		24	2.7	15	4.8	50		36	21	0.0	0.2		135			71	30	0.8	237	6.3
Feb. 25.........	6.1	1.1		16	2.8	12	5.0	44		23	16	.1	.2		98			51	15	.7	181	7.0
Apr. 8.........	.4	4.5		29	3.7	15	4.7	105		14	15	.1	.5		138			88	2	.7	250	6.8
Apr. 27.........	616	6.1		5.8	1.5	4.4	2.9	20		7.2	5.4	.0	.5		44			21	4	.4	72	6.1
109. RED RIVER NEAR NEW BOSTON																						
Nov. 1, 1960.....				101	30	225		122		249	358		1.3		1110	1.51		375	275	5.1	1740	8.0
Nov. 12.........				106	33	215		140		249	350		.8		1130	1.54		400	286	4.7	1760	8.0
Dec. 23.........				94	21	184		110		187	308		1.2		849	1.15		320	230	4.5	1520	7.6
Jan. 31, 1961....				110	26	205		144		219	340		1.1		972	1.32		380	262	4.6	1700	7.9
Mar. 11.........				55	14	96		114		99	145		1.6		493	.67		194	100	3.0	822	8.2
Apr. 12.........				82	20	159		122		172	250		1.9		796	1.08		288	188	4.1	1280	8.4
May 10..........				27	5.5	24		72		29	36		2.6		180	.24		90	31	1.1	294	8.2
July 26.........				54	13	98		90		110	150		2.3		524	.71		190	116	3.1	836	8.1
Sept. 1.........				122	28	228		188		242	360		1.3		1200	1.63		420	266	4.8	1820	8.4
Sept. 20.........				95	30	227		116		240	360		1.1		1070	1.46		360	265	5.2	1760	8.0
Sept. 27.........				98	31	226		134		240	355		1.0		1090	1.48		370	260	5.1	1770	8.1
Oct. 11.........				101	30	203		120		225	342		1.0		996	1.35		375	276	4.6	1660	7.9
Oct. 17.				79	22	176		108		185	275		1.0		834	1.13		288	200	4.5	1380	7.8
Nov. 1..........				115	32	232		168		205	385		12		1180	1.60		420	282	4.7	1900	8.3
Dec. 6..........				88	32	187		122		200	318		.8		1000	1.36		350	250	4.4	1580	8.0
Jan. 4, 1962.....				85	27	163		142		178	265		1.0		884	1.20		322	206	4.0	1400	8.4
Feb. 2..........				58	13	98		100		110	150		.7		544	.74		196	114	3.0	857	8.0
Mar. 2..........				24	5.8	38		76		33	49		.4		166	.23		84	22	1.8	277	7.8
Apr. 3..........				28	3.9	23		84		28	26		2.6		198	.27		86	17	1.1	280	7.8
May 2..........				26	10	27		100		37	32		.8		238	.32		108	26	1.1	355	7.8
June 19.........				111	31	237		136		255	385		.0		1220	1.66		405	294	5.1	1830	7.8
Aug. 14.........				101	31	210		150		238	330		.7		1110	1.51		380	257	4.7	1730	8.1
Sept. 11.........				31	5.5	23		102		28	25		1.4		195	.27		100	16	1.0	296	7.9
Oct. 10.........				--	--	172		124		192	275		.0		907	1.23		315	213	4.2	1420	7.6
Nov. 8..........				--	--	142		130		155	220				742	1.01		270	163	3.8	1170	8.3
Dec. 5..........				--	--	96		126		111	146		--		543	.74		216	113	2.9	879	8.0
Jan. 3, 1963.....				--	--	103		148		116	158		--		593	.81		242	121	2.9	961	8.0
Jan 30..........				--	--	164		144		191	260		--		868	1.18		326	208	4.0	1390	7.9
Feb. 27.........				--	--	113		208		124	174		--		687	.93		300	130	2.8	1090	8.1
Mar. 27.........				--	--	23		88		31	32		--		208	.28		100	28	1.0	306	8.0
Apr. 24.........				--	--	144		148		155	240		--		802	1.09		308	187	3.6	1280	8.3
May 22..........				--	--	171		148		205	270		--		922	1.25		344	223	4.0	1450	8.3
June 19.........				--	--	192		142		225	295		--		992	1.35		350	234	4.5	1540	8.4
July 18.........				--	--	64		92		40	120		--		380	.52		148	73	2.3	620	8.2
Aug. 12....				--	--	204		152		228	320		--		1030	1.40		370	245	4.6	1640	8.3

See footnotes at end of table.

Table 6.--Chemical Analyses of Water From Streams and Reservoirs at Sites Other Than Daily Stations in the Red River Basin, Texas--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3) a	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (calculated) Milligrams per liter	Tons per acre-foot	Tons per day	Hardness as $CaCO_3$ Calcium, Magnesium	Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
110. BARKMAN CREEK NEAR LEARY																						
May 23, 1961......	2.3	5.7	0.00	6.4	2.4	11	2.1	35		3.8	9.0	0.3	1.0		59	--		26	0	--	108	6.2
Oct. 23...........	.6	11		7.5	2.2	13		33		6.0	12	1.2	2.8		72	0.10		28	50	1.1	143	6.0
Nov. 30...........	4.4	11		4.5	1.5	14		25		8.8	12	.2	.8		65	.09		17	64	1.5	118	5.8
Mar. 16, 1962.....	18.2	8.3		3.5	1.1	8.0	.7	16		7.2	7.5	.1	.0		44	.06		13	55	1.0	73	5.8
May 26............	.5	9.8		8.0	2.4	13		44		2.8	14	.1	.0		72	.10		30	49	1.0	131	6.7
July 7............	.5	9.1		8.0	2.4	12		40		4.4	12	.2	.5		69	.09		30	46	1.0	127	6.6
July 31...........	1.6	8.9		6.0	1.4	14		33		11	8.0	.6	.5		66	.09		21	60	1.3	129	5.8
Sept. 18..........	.9	12		7.2	1.8	13	2.6	36		6.8	10	2.0	.2		74	.10		25	50	1.1	129	6.3

a Includes the equivalent of any carbonate (CO_3) present.

b Field estimate.

c Mean discharge.

Table 7.--Chemical Analyses of Water From Streams at Selected Sites in the Red River Basin, Oklahoma

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs) a	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
A. SALT FORK RED RIVER NEAR VINSON, OKLA.																						
Dec. 21, 1959.....				220	56	134		70	0	719	185	0.6	4.4		1350	1.84		780	722	2.1	1880	8.2
Jan. 14, 1960.....				250	65	156		130	0	820	190	.7	2.5		1660	2.26		890	784	2.3	2050	8.0
Jan. 26..........				210	67	146		86	0	727	202	.6	3.8		1400	1.90		800	730	2.2	1970	8.1
Mar. 14..........				290	92	161		64	0	1050	215	.7	2.3		1970	2.68		1100	1050	2.1	2380	7.9
Apr. 18..........				460	105	234		144	0	1540	260	1.0	.8		2850	3.88		1580	1460	2.6	3230	7.5
Apr. 28..........				112	49	100		152	0	402	108	--	2.8		950	1.29		480	356	2.0	1270	8.1
May 16...........				464	122	269		204	0	1600	292	1.0	.0		3020	4.11		1660	1490	2.9	3440	7.4
June 21..........				404	93	201		124	0	1360	220	--	.2		2540	3.45		1390	1290	2.3	2820	8.0
July 19..........				440	93	180		180	0	1310	255	--	.1		2550	3.47		1480	1330	2.0	2940	7.7
Sept. 13.........				320	51	181		138	0	969	200	--	1		1890	2.57		1010	897	2.5	2270	7.5
Oct. 18..........				128	20	49		232	0	237	49	--	.1		645	.88		400	210	1.1	909	7.5
Nov. 15..........				332	73	191		148	0	1090	205	--	.1		2110	2.87		1130	1010	2.5	2430	7.8
Jan. 17, 1961.....				344	78	200		166	0	1120	220	--	2.8		2180	2.96		1180	1040	2.5	2530	7.8
Feb. 14..........				296	83	166		70	0	1050	205	--	1.4		2020	2.75		1080	1020	2.2	2350	8.0
Mar. 14..........				448	88	206		152	0	1430	222	--	2.9		2680	3.64		1480	1360	2.3	2910	7.6
Apr. 19..........				412	105	205		150	0	1440	200	--	2.4		2640	3.59		1460	1340	2.3	2870	7.7
May 17...........				160	73	191		402	0	644	82	--	.2		1410	1.92		700	370	3.1	1900	7.9
June 21..........				388	78	157		124	0	1210	192	--	.2		2370	3.22		1290	1190	1.9	2620	7.7
July 12..........				232	44	107		128	0	670	135	--	.5		1340	1.82		760	655	1.7	1710	8.1
Aug. 1...........				352	78	146		124	0	1130	170	--	.0		2050	2.79		1200	1100	1.8	2380	7.9
Sept. 26.........				476	100	161		116	0	1510	200	--	1.9		2660	3.62		1600	1500	1.8	2860	7.8
Oct. 24..........				504	103	188		120	0	1620	215	--	.0		2800	3.81		1680	1580	2.0	3070	7.7
Nov. 14..........				--	--	177		142	0	1180	212	--	1.0		2240	3.05		1260	1140	2.2	2630	7.7
Dec. 5...........				--	--	196		60	0	1160	225	--	2.9		2120	2.88		1150	1100	2.5	2520	7.7
Jan. 31, 1962.....				--	--	173		132	0	968	190	--	2.4		1860	2.53		1010	902	2.4	2280	8.0
Mar. 7...........				--	--	193		96	0	1250	240	--	1.2		2420	3.29		1300	1220	2.3	2850	7.9
Mar. 28..........				--	--	213		92	0	1380	220	--	1.4		2530	3.44		1360	1280	2.5	2860	7.9
Apr. 25..........				--	--	203		62	0	1370	230	--	--		2550	3.47		1360	1310	2.4	2870	7.6
May 23...........				--	--	182		166	0	772	220	--	--		1680	2.28		855	719	2.7	2160	7.8
June 27..........				--	--	204		122	0	626	295	--	--		1370	1.86		725	625	3.3	1710	7.9
Sept. 25.........				--	--	109		140	0	1020	170	--	--		2020	2.75		1180	1070	1.4	2480	7.7
B. SALT FORK RED RIVER AT MANGUM, OKLA.																						
Water year 1947																						
Maximum, Aug. 11-20, 1947	--			488	158	355		118	0	1690	555		0.5		3300	4.49	--	1870	1770	--	4080	--
Minimum, Oct. 7-9, 12, 14, 1946....	1360			170	36	86		134		485	100		3.0		946	1.29	3470	572	462	--	1350	--
Water year 1948																						
Maximum, Apr. 21-30, 1947	6.68			563	135	198		123		1840	272		2.0		3080	4.19	56	1970	1870	--	3500	--
Minimum, June 21-22,29-30	1733			243	36	83		108		687	93		1.9		1200	1.63	5780	754	666	--	1520	--
Apr. 7, 1949......	--			350	83	175		136		1110	232		1.0		2020	--	--	1220	1100	--	2570	--
Feb. 10, 1950.....	--			432	92	152		141		1290	232		1.0		2270	3.09	--	1460	1340	--	2870	--
Dec. 2...........	--			459	97	169		161		1410	220		2.3		2610	3.55	--	1540	1410	--	2920	--
Feb. 6, 1951......	--			401	86	162		167		1240	195		3.0		2360	3.21	--	1350	1220	--	2750	--
Apr. 8...........	--			488	111	199		137		1570	255		.9		2850	3.88	--	1670	1560	--	3330	8.0

See footnotes at end of table.

Table 7.--Chemical Analyses of Water From Streams at Selected Sites in the Red River Basin, Oklahoma--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs) a	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
B. SALT FORK RED RIVER AT MANGUM, OKLA.--Continued																						
May 19	--	--	--	196	38	83		136		538	109	--	0.8	--	1220	1.66	--	645	534	--	1480	8.0
Jan. 16, 1952	32.8	--	--	389	88	189		149		--	212	--	--	--	--	--	--	1330	1210	--	2610	7.7
Feb. 10, 1954	14.8	--	--	517	90	191		123		--	252	--	--	--	--	--	--	1660	1560	2.0	3250	7.8
June 3, 1955	7060	--	--	126	91	56		255		--	70	--	--	--	--	--	--	690	480	.9	1560	7.0
July 5	5.7	--	--	216	102	179		116		--	210	--	--	--	--	--	--	960	865	2.5	2610	7.1
Oct. 3	2160	--	--	220	17		7.8	216		--	18	--	--	--	--	--	--	620	443	.1	1090	7.1
Oct. 28, 1959	.2	18	--	520	74	131		144	0	1440	188	0.5	1.2	0.42	2440	3.32	1.32	1600	1480	1.4	2830	7.6
Dec. 21	45	--	--	224	49	125		132	0	677	152	.6	4.3	--	1330	1.77	158	760	652	2.0	1740	8.1
Jan. 14, 1960	300	--	--	276	64	149		144	0	846	192	.6	3.6	--	1600	2.18	1300	950	832	2.1	2090	8.2
Jan. 26	b407	--	--	300	66	156		114	0	933	205	.7	4.2	--	1720	2.34	1890	1020	926	2.1	2280	8.1
Feb. 25	120	20	0.00	508	125	192		220	0	1580	260	1.0	3.7	--	2820	3.84	914	1780	1600	2.0	3290	7.8
Apr. 18	2.0	--	--	544	142	213		124	0	1870	252	.9	.6	--	3280	4.46	17.7	1940	1840	2.1	3540	7.5
May 25	100	14	.00	320	71	150		118	0	1020	182	.7	.1	.41	1950	2.65	526	1090	994	2.0	2280	7.4
June 20	26	--	--	408	64	224		118	0	1320	210	--	.2	--	2400	3.26	168	1280	1180	2.7	2740	8.2
July 12	14	17	.00	192	45	129		104	0	619	152	.7	.6	.24	1250	1.70	47.2	665	580	2.2	1660	7.8
July 19	11	--	--	336	56	159		112	0	1030	178	--	.2	--	1950	2.65	57.9	1070	978	2.1	2270	8.1
Sept. 13	b10	--	--	272	60	110		140	0	784	165	--	.7	--	1560	2.12	42.1	925	810	1.6	1970	7.7
Oct. 11	12	17	--	480	88	180		98	0	1510	210	.6	1.0	.47	2710	3.69	87.8	1560	1480	2.0	2920	7.6
Oct. 17	1890	--	--	140	34	58		118	2	387	78	--	3.7	--	842	1.15	4300	490	390	1.1	1120	8.3
Nov. 14	100	--	--	362	92	196		152	0	1260	190	--	1.4	--	2300	3.13	621	1280	1160	2.4	2570	8.0
Jan. 16, 1961	79	--	--	380	71	199		174	0	1190	205	--	2.4	--	2300	3.13	490	1240	1100	2.5	2590	8.1
Jan. 17	79	18	--	376	93	167		164	0	1200	210	.6	1.6	.30	2280	3.10	486	1320	1190	2.0	2610	7.7
Feb. 13	84	--	--	304	73	169		188	0	965	190	--	.1	--	1910	2.60	433	1060	906	2.3	2300	7.8
Mar. 13	30	--	--	480	86	222		148	0	1550	210	--	2.5	--	2760	3.75	224	1550	1430	2.5	3010	8.0
Apr. 18	15	--	--	364	112	268		182	0	1170	415	--	.4	--	2630	3.58	106	1370	1220	3.1	3160	8.2
Apr. 19	14	16	--	444	122	187		144	0	1550	200	.6	2.0	.75	2720	3.70	103	1610	1490	2.0	3000	7.7
June 20	37	--	--	364	76	152		120	0	1130	195	--	.2	--	2260	3.07	226	1220	1120	1.9	2530	7.6
July 12	99	--	--	204	39	84		212	0	530	90	--	.0	--	1120	1.52	299	670	497	1.4	1440	7.6
July 31	.5	--	--	174	57	79		132	0	560	106	--	.8	--	1160	1.58	1.57	670	562	1.3	1470	7.8
Nov. 13	6.8	--	--	--	--	158		112	0	1360	222	--	2.5	--	2520	3.43	46.3	1480	1390	1.8	2850	7.8
Dec 4	52	--	--	--	--	175		118	0	1140	210	--	1.3	--	2140	2.91	300	1200	1100	2.2	2520	8.0
Jan. 30, 1962	75	--	--	--	--	146		82	0	887	155	--	2.8	--	1670	2.27	338	895	828	2.1	2070	7.9
Mar. 7	b32	--	--	--	--	208		64	0	1300	260	--	--	--	2560	3.48	221	1320	1270	2.5	2910	7.8
Mar. 28	b2.5	--	--	--	--	296		108	0	1940	280	--	1.9	--	3220	4.38	21.7	1860	1770	3.0	3500	7.9
Apr. 25	b3.6	--	--	--	--	180		104	0	1590	220	--	--	--	2840	3.86	27.6	1660	1580	1.9	3100	7.7
May 22	b28	--	--	--	--	236		128	0	1280	280	--	--	--	2500	3.40	189	1320	1220	2.8	2910	7.6
June 27	b84	--	--	--	--	124		180	0	720	150	--	--	--	1460	1.99	331	840	692	1.9	1850	7.8
Sept. 24	30	--	--	--	--	185		148	0	850	245	--	--	--	1610	2.19	130	950	828	2.6	1940	7.7
C. NORTH FORK RED RIVER NEAR CARTER, OKLA.																						
Oct. 28, 1959	b12	14	--	332	95	359		232	0	1060	500	0.5	0.7	0.41	2480	3.37	80.4	1220	1030	4.5	3490	7.8
Dec. 10	32.9	--	--	270	96	279		212	0	919	388	--	.6	--	2190	2.98	194	1070	896	3.7	2910	8.0
Dec. 21	161	--	--	142	38	147		178	2	371	205	.6	5.8	--	998	1.36	434	510	360	2.8	1500	8.3
Feb. 25, 1960	250	21	0.01	270	121	260		368	0	893	350	1.0	10	.23	2210	3.01	1490	1170	868	3.3	2890	7.9
May 24	37	14	.00	270	101	252		154	0	1030	310	.7	1.0	.52	2240	3.05	224	1090	964	3.3	2750	7.3
July 12	156	17	.00	204	56	194		172	0	635	252	.7	1.8	.26	1500	2.04	632	740	599	3.1	2100	7.5
Oct. 11	17	16	--	244	93	261		170	0	947	305	.4	1.0	.53	2080	2.83	95.5	990	850	3.6	2650	7.8
Jan. 17, 1961	204	22	--	250	96	242		270	0	856	305	1.0	2.6	.28	1990	2.71	1100	1020	798	3.3	2630	7.8
Apr. 19	103	17	--	208	95	251		200	0	839	295	.6	1.8	.47	1910	2.60	531	910	746	3.6	2480	7.6

See footnotes at end of table.

Table 7.--Chemical Analyses of Water From Streams at Selected Sites in the Red River Basin, Oklahoma--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs) a	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
C. NORTH FORK RED RIVER NEAR CARTER, OKLA.--Continued																						
Nov. 14, 1961.....	39					148		226	0	750	210		0.5		1700	2.31	179	940	755	2.1	2190	8.0
Dec. 5............	83					195		104	0	723	265		2.0		1610	2.19	361	790	705	3.0	2160	8.2
Jan. 31, 1962.....	106					195		220	0	611	268		.0		1510	2.05	432	770	590	3.1	2100	7.9
Mar. 7............	b70					227		196	0	730	335		--		1860	2.53	352	900	740	3.3	2460	8.0
Mar. 28...........	b22					275		168	0	960	340		.6		2160	2.94	128	1020	882	3.7	2780	8.0
Apr. 25...........	b22					247		96	0	955	315		--		2040	2.77	121	980	902	3.4	2630	7.8
May 23............	b160					229		210	0	625	345		--		1710	2.33	739	810	638	3.5	2380	7.9
June 26...........	b107					137		232	0	430	185		--		1160	1.58	335	600	410	2.4	1650	7.9
Aug. 28...........	b.6					128		190	0	610	175		--		1420	1.93	2.30	760	604	2.0	1900	8.1
Sept. 25..........	b86					129		232	0	460	172		--		1180	1.60	274	630	440	2.2	1670	8.0
D. CACHE CREEK NEAR WALTERS, OKLA.																						
Oct. 2, 1962......	27.1					--					71							--		--	715	
Oct. 23...........	38.9					68					57							120		2.7	563	
Nov. 14...........	b38					--					56							--		--	659	
Dec. 4............	757					23					20							104		1.0	312	
Dec. 17...........	49.5					--					50							--		--	635	
Jan. 7, 1963......	43.4					--					57							--		--	698	
Jan. 30...........	37.1					--					56							--		--	731	
Mar. 5............	30.3					--					68							--		--	789	
Apr. 3............	76.4					51					54							146		1.8	525	
Apr. 22...........	31.2					--					72							--		--	777	
May 21............	31.7					74					64							234		2.1	774	
June 4............	1010					21					10							130		.8	346	
June 24...........	28.2					--					66							--		--	715	
July 10...........	19.5					74					64							180		2.4	677	
Aug. 5............	17.0					--					64							--		--	685	
Aug. 27...........	14.0					65					60							172		2.2	665	
Sept. 17..........	b18					65					54							170		2.2	638	
E. DEEP RED RUN NEAR RANDLETT, OKLA.																						
Nov. 12, 1959.....	16			74	24	138		190	8	99	220	0.3	1.8		658	0.89	28.4	284	115	3.6	1170	8.5
Jan. 6, 1960......	24.5			70	89	346		336	0	--	580	--	--		--	--	--	540	264	6.5	2560	8.2
Jan. 28...........	15.4			75	91	502		140	0	--	840	--	--		--	--	--	560	446	9.2	3330	8.1
Mar. 9............	11.5			78	94	540		168	0	--	910	--	--		--	--	--	580	442	9.8	3610	8.1
Mar. 16...........	b11			63	37	216		196	0	130	342	.7	.8		886	1.20	26.3	310	150	5.3	1560	8.2
Apr. 1............	9.2			66	57	314		400	0	--	430	--	--		--	--		400	72	6.8	2180	8.2
June 13...........	b34			66	19	121		208	8	69	175	--	1.7		655	.89	60.1	242	58	3.4	1020	8.4
July 13...........	b4.0			54	13	107		200	6	47	140	--	1.2		533	.72	5.76	188	14	3.4	845	8.4
July 20...........	24.0			24	6.8	34		120	0	19	30	--	.2		182	.25	11.8	88	0	1.6	310	7.8
Aug. 9............	b.2			45	17	85		234	4	36	93	--	1.2		438	.60	.24	184	0	2.7	687	8.3

See footnotes at end of table.

Table 7.--Chemical Analyses of Water From Streams at Selected Sites in the Red River Basin, Oklahoma--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs) a	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
F. WASHITA RIVER NEAR DURWOOD, OKLA.																						
Water year 1951																						
Maximum, Jan. 21-31,1951.	436	--		153	60	63		368	--	337	79	--	1.4		936	1.28	1100	628	327	--	1330	--
Minimum, May 2-3.	7850	--		50	17	17		153	8	56	21	--	5.1		282	.39	5980	195	56	--	440	8.6
Weighted average.	1916	--		78	27	29		185	--	159	37	--	2.8		478	.65	2470	306	154	--	693	--
Water year 1952																						
Maximum, Dec. 11-20,1951.	233	15		136	53	77	3.8	307	2	337	95	0.3	1.3	0.24	912	1.24	574	558	302	--	1290	8.3
Minimum, Nov. 2..	1060	--		11	3.3	7.1		22	--	23	4.5	--	10		70	.10	200	41	23	--	45	7.2
Weighted average.	629	--		75	29	43		189	--	169	46	--	5.2		499	.68	847	306	151	--	736	--
Water year 1953																						
Maximum, June 1-2, 1953..	148	--		136	49	103		137	--	431	144	--	1.0		1050	1.43	422	541	428	1.9	1410	8.2
Minimum, May 13..	3410	--		32	4.6	12		111	2	17	6.5	--	3.8		140	.19	1290	99	4	.5	232	8.3
Weighted average.	518	--		65	19	35		162	--	119	40	--	3.7		390	.53	545	240	108	1.0	595	--
Water year 1954																						
Maximum, Sept.11-14,1954.	16.2	--		124	65	123		190	2	432	160	--	1.6		1050	1.43	46	575	416	2.2	1620	8.3
Minimum, June 8..	7980	--		40	5.8	7.7		110	4	33	9.5	--	5.9		160	.22	3450	124	25	.3	291	8.3
Weighted average.	1258	--		63	16	26		153	--	101	36	--	2.5		350	.48	1190	223	98	.8	545	--
Water year 1955																						
Maximum, May 5-10, 1955..	124	--		100	63	95		205	--	389	125	--	2.6		972	1.32	325	510	342	1.8	1390	8.1
Minimum, Oct. 1, 1954....	4370	--		28	2.4	7.9		93	--	16	5.4	--	3.9		110	.15	1300	80	4	.4	193	8.1
Weighted average.	878	--		64	21	23		157	--	112	33	--	3.5		362	.49	858	246	118	.6	562	--
Water year 1956																						
Maximum, July 30, 1956...	120	--		144	60	139		128	--	497	200	--	2.5		1160	1.58	376	605	500	2.5	1710	7.8
Minimum,Oct.1-4, 7-10, 1955......	3589	--		51	15	14		126	--	80	18	--	3.9		264	.36	2560	188	84	.4	444	7.8
Weighted average.	440	--		87	35	46		185	--	211	62	--	4.1		573	.78	681	361	210	1.1	880	--
Water year 1957																						
Maximum, Jan. 23, 1957...	188	--		100	49	182		164	4	269	300	--	2.3		1170	1.59	594	450	309	3.7	1830	8.4
Minimum, May 17-20.......	64550	--		36	7.5	8.5		130	--	18	8.8	--	2.5		169	.23	29450	121	14	.3	268	8.1
Weighted average.	3555	--		54	16	20		162	--	70	26	--	3.2		303	.41	2850	200	68	.6	465	--
Water year 1958																						
Maximum, June 16-20,1958.	410	--		106	49	66		232	10	263	90	--	1.2		824	1.12	912	465	258	1.3	1090	8.5
Minimum, Aug. 10-13......	1880	--		46	11	21		152	--	42	26	--	1.4		222	.30	1130	160	36	.7	418	7.9
Weighted average.	934	--		84	31	43		229	--	149	62	--	1.9		522	.71	1320	337	150	1.0	787	--
Water year 1959																						
Maximum, Sept. 14-17,1959	224	--		178	63	98		120	--	650	100	--	2.0		1210	1.65	732	705	606	1.6	1590	7.7
Minimum,June 1-3.	4533	--		66	11	15		132	6	98	12	--	3.7		280	.38	3430	208	90	.4	440	8.4
Weighted average.	640	--		87	28	41		175	--	198	49	--	2.8		531	.72	918	332	188	1.0	778	--

See footnotes at end of table.

Table 7.--Chemical Analyses of Water From Streams at Selected Sites in the Red River Basin, Oklahoma--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs) a	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
F. WASHITA RIVER NEAR DURWOOD, OKLA.--Continued																						
Water year 1960																						
Maximum, Dec. 1-10, 1959.	447	--		188	73	77		336	--	509	92	--	3.2		1200	1.63	1450	770	494	1.2	1560	8.0
Minimum, May 19-20, 1960.	17200	--		46	11	18		142	6	45	20	--	.2		229	.31	10630	162	36	.6	376	8.4
Weighted average.	1594	--		94	32	40		202	--	212	46	--	2.4		572	.78	2460	366	40	.9	812	--
Water year 1961																						
Maximum, Mar.17-24, 1961.	953	9.0		114	41	68	2.6	248	2	250	110	0.3	1.2		1140	1.09	2930	455	248	1.4	1140	8.3
Minimum, Dec. 9, 1960....	3040	--		47	9.8	27		144	2	37	38	--	5.0		262	.36	2150	158	36	.9	421	8.4
Weighted average.	1135	12		88	81	42		197	0	186	56	.3	2.4		564	.77	1730	348	182	1.0	800	--
Water year 1962																						
Maximum, Feb. 11-20, 1962	498	--		170	68	91		296	4	495	98	--	--		1190	1.62	1600	705	456	1.5	1500	8.3
Minimum, June 19.	9760	--		39	10	22		132	0	46	22	--	--		221	.30	5820	140	32	.8	345	8.2
Weighted average.	1345	--		--	--	43		199	3	213	49	--	--		581	.79	2110	363	195	1.0	840	--
Water year 1963																						
Maximum, July 23-28, 1963	80.8	--		--	--	109		142	0	670	130	--	--		1450	1.97	316	760	644	1.7	1730	8.2
Minimum, Oct. 28-31, 1962	5510	--		47	12	15		122	0	63	23	--	--		260	.35	3870	166	66	.5	412	8.2
Weighted average.	629	--		95	37	56		162	0	269	68	--	--		661	.90	1120	390	254	1.2	938	8.2
Water year 1964																						
Maximum, May 1-3, 1964...	254	--		--	--	105		124	8	695	138	--	--		1440	1.96	988	805	690	1.6	1760	8.4
Minimum, Aug. 18.	722	--		--	--	17		124	0	37	15	--	--		190	.26	370	124	22	.7	328	8.0
Weighted average.	340	--		--	--	42		144	0	207	54	--	--		552	.75	507	324	200	.9	777	8.3
G. CLEAR BOGGY CREEK NEAR CANEY, OKLA.																						
Oct. 19, 1961.....	139			59	13	23		212	0	21	38		0.2		273	0.37	102	200	26	0.7	461	8.2
Nov. 2...........	b65			51	21	39		214	0	21	70		.7		324	.44	56.9	212	37	1.2	573	8.2
Dec. 7...........	b274			38	16	36		156	0	23	62		.1		274	.37	203	162	34	1.2	468	8.2
Mar. 2, 1962......	102			85	26	56		320	0	30	106		.0		483	.66	133	320	58	1.4	871	8.1
Apr. 4...........	258			--	--	26		206	4	31	32		--		285	.39	198	196	21	.8	467	8.4
May 9.............	124			--	--	39		140	0	33	57		--		261	.35	87.4	144	30	1.4	457	8.2
June 20...........	680			--	--	9.0		94	0	13	12		--		110	.15	202	88	11	.4	208	7.6
Aug. 14...........	b14			--	--	56		190	0	11	115		--		388	.53	14.7	208	52	1.7	668	8.2
Sept. 11..........	b212			--	--	11		166	0	11	16		--		210	.29	120	146	10	.4	332	8.2
Oct. 1............	64			--	--	8.5		100	0	8.6	11		--		138	.19	23.8	88	6	.4	211	8.1
Nov. 6............	134			--	--	25		194	4	25	37		--		290	.39	105	190	24	.8	463	8.4
Dec. 4............	879			--	--	18		154	2	20	29		--		229	.31	543	152	22	.6	370	8.3
Jan. 2, 1963......	173			--	--	36		176	0	34	60		--		301	.41	140	186	42	1.1	530	8.2
Jan. 31...........	78			--	--	50		204	0	34	90		--		378	.51	79.6	220	53	1.5	669	8.1
Feb. 26...........	56			--	--	57		170	2	33	101		--		357	.48	54.0	196	53	1.8	643	8.3

See footnotes at end of table.

Table 7.--Chemical Analyses of Water From Streams at Selected Sites in the Red River Basin, Oklahoma--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs) a	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
G. CLEAR BOGGY CREEK NEAR CANEY, OKLA.--Continued																						
Mar. 26, 1963	107			--	--	30		196	0	30	47				290	0.39	83.8	192	31	1.0	504	8.2
Apr. 23	68			--	--	--		--	--	--	--				309	.42	56.7	194	37	.9	504	8.2
May 21	58			26	22	53		136	4	30	86				319	.43	50	156	38	1.8	537	8.5
June 18	26			27	24	63		144	4	22	112				347	.47	24.4	168	43	2.1	605	8.3
July 16	14			30	28	61		166	4	17	116				358	.49	13.5	190	47	1.9	649	8.3
Aug. 12	21			38	28	64		190	4	17	122				395	.54	22.4	212	50	1.9	697	8.4
Sept. 9	3.5			54	28	66		228	8	15	124				443	.60	4.19	248	48	1.8	757	8.5
Dec. 5	8.6			--	--	--		--	--	--	52				--	--	--	--	--	--	631	--
Dec. 18	9.9			--	--	--		--	--	--	58				--	--	--	--	--	--	658	--
Dec. 30	9.2			--	--	62		262	4	23	140				480	.65	11.9	308	86	1.5	878	8.4
Jan. 6, 1964	10			--	--	28		270	0	27	65				379	.52	10.2	280	59	.7	639	--
Jan. 20	11			--	--	--		--	--	--	67				--	--	--	--	--	--	527	--
Jan. 28	8.6			--	--	--		--	--	--	82				--	--	--	--	--	--	689	--
Feb. 6	20			--	--	38		196	4	21	76				322	.44	17.4	214	47	1.1	563	8.4
Feb. 12	17			--	--	--		--	--	--	81				--	--	--	--	--	--	648	--
Feb. 17	14			--	--	--		--	--	--	80				--	--	--	--	--	--	675	--
Feb. 24	11			--	--	--		--	--	--	137				--	--	--	--	--	--	858	--
Mar. 2	11			--	--	46		162	4	35	95				366	.50	10.9	210	70	1.4	644	8.4
Mar. 16	52			--	--	--		--	--	--	46				--	--	--	--	--	--	507	--
Mar. 20	666			--	--	11		108	0	21	21				192	.26	345	116	27	.4	284	7.6
Mar. 24	90			--	--	--		--	--	--	30				--	--	--	--	--	--	422	--
Mar. 31	31			--	--	--		--	--	--	80				--	--	--	--	--	--	612	--
Apr. 6	1650			--	--	16		176	0	20	27				233	.32	1040	168	24	.5	393	8.1
Apr. 14	89			--	--	--		--	--	--	34				--	--	--	--	--	--	470	--
Apr. 21	50			--	--	--		--	--	--	86				--	--	--	--	--	--	693	--
May 1	34			--	--	--		--	--	--	64				--	--	--	--	--	--	624	--
May 7	29			--	--	32		260	0	33	80				445	.61	34.8	292	79	.8	709	8.1
May 11	2670			--	--	13		136	0	15	18				159	.22	1150	124	12	.5	293	8.0
May 15	326			--	--	--		--	--	--	17				--	--	--	--	--	--	341	--
May 22	68			--	--	--		--	--	--	26				--	--	--	--	--	--	442	--
May 28	50			--	--	--		--	--	--	37				--	--	--	--	--	--	497	--
June 10	28			--	--	24		242	0	31	40				328	.45	24.8	234	35	.7	530	8.2
June 18	2700			--	--	--		--	--	7.0	7.2				--	--	--	--	--	--	129	--
June 19	3380			--	--	3.2		60	0	7.0	6.4				74	.10	675	58	9	.2	123	7.5
July 13	6.1			--	--	25		212	0	20	43				292	.40	4.81	200	26	.8	496	8.1
July 28	1.1			--	--	27		216	0	21	60				308	.42	.91	224	47	.8	552	8.0
Aug. 5	.2			--	--	--		--	--	--	70				--	--	--	--	--	--	589	--
Aug. 19	.1			--	--	37		222	0	23	72				337	.46	.09	226	44	1.1	606	7.9
Aug. 25	5.1			--	--	--		--	--	--	103				--	--	--	--	--	--	656	--
Sept. 3	29			--	--	--		--	--	--	21				--	--	--	--	--	--	301	--
Sept. 14	3.9			--	--	--		--	--	--	30				--	--	--	--	--	--	391	--
Sept. 23	2940			--	--	--		--	--	--	6.0				--	--	--	--	--	--	202	--
Sept. 29	622			--	--	10		98	0	10	20				148	.20	249	96	16	.4	246	7.6

See footnotes at end of table.

Table 7.--Chemical Analyses of Water From Streams at Selected Sites in the Red River Basin, Oklahoma--Continued

(Results in milligrams per liter except as indicated. Calculated values for sodium plus potassium are centered between the two columns.)

Date of collection	Discharge (cfs) a	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Milligrams per liter	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
H. KIAMICHI RIVER NEAR BELZONI, OKLA.																						
Oct. 18, 1961.....	b324	--		4.2	3.2	3.4		22	0	7.2	4.3		0.0		44	0.66	38.5	24	6	0.3	52	7.1
Nov. 2...........	133	--		5.3	1.7	7.6		24	0	6.6	6.1		1.7		63	.09	22.6	20	1	.7	68	7.5
Dec. 14..........	2770	--		3.2	1.7	5.8		16	0	7.0	4.6		.8		43	.06	322	15	2	.6	45	7.2
Mar. 2, 1962......	b2080	--		2.4	1.9	6.9		16	0	8.2	3.5		.7		42	.06	236	14	1	.9	49	7.3
Apr. 3...........	2910	--		2.2	1.6	5.3		16	0	6.2	2.6		.7		51	.07	401	12	0	.7	49	7.3
May 3............	1540	--		4.6	1.3	6.2		24	0	6.2	3.0		.6		56	.08	233	17	0	.7	61	7.4
June 20..........	264	--		4.2	1.6	6.0		22	0	6.6	3.6		.2		44	.06	31.4	17	0	.6	63	7.2
Aug. 14..........	5.3	--		6.4	1.9	9.4		36	0	5.2	6.2		1.0		61	.08	.87	24	0	.8	90	7.6
Sept. 13.........	236	--		3.7	2.2	8.3		26	0	6.0	5.4		1.0		51	.07	32.5	18	0	.8	67	7.5
Nov. 8...........	427	14		4.8	1.0	6.0		18	0	6.0	5.6		--		41	.06	47.3	16	1	.6	57	7.1
Dec. 6...........	1785	10		4.8	1.0	5.3		16	0	6.2	5.6		--		46	.06	222	16	3	.6	54	7.0
Jan. 4, 1963......	392	11		5.2	.7	6.0		16	0	6.4	6.6		--		44	.06	46.6	16	3	.6	60	7.1
Jan. 31..........	194	11		4.0	1.5	8.7		20	0	7.8	7.4		--		41	.06	21.5	16	0	1.0	68	7.2
Feb. 28..........	92	6.8		8.0	1.0	8.7		24	0	9.2	9.8		--		50	.07	12.4	24	4	.8	88	7.3
Mar. 28..........	3050	17		4.0	1.5	5.5		16	0	5.8	6.3		--		51	.07	420	16	3	.6	57	7.3
Apr. 25..........	210	13		7.2	.5	8.3		24	0	7.0	7.7		--		46	.06	26.1	20	0	.8	77	7.5
May 23...........	63	16		6.4	1.0	6.7		24	0	5.8	6.4		--		47	.06	8.00	20	0	.6	70	7.5
June 20..........	73	9.6		7.2	1.0	6.2		22	0	7.4	7.1		--		51	.07	10.0	22	4	.6	79	7.4
July 19..........	30	11		4.0	1.9	3.0		16	0	5.4	4.4		--		52	.07	4.21	18	5	.3	56	7.5
Aug. 14..........	9.4	8.4		3.2	1.9	4.8		20	0	4.0	4.2		--		49	.07	1.24	16	0	.5	54	7.6
Sept. 11.........	4.9	8.4		3.2	2.4	5.3		20	0	4.3	6.0		--		48	.07	.64	18	2	.5	60	7.7

a Flow shown for maximum, minimum, and weighted average is mean discharge for the period.

b Field estimate.

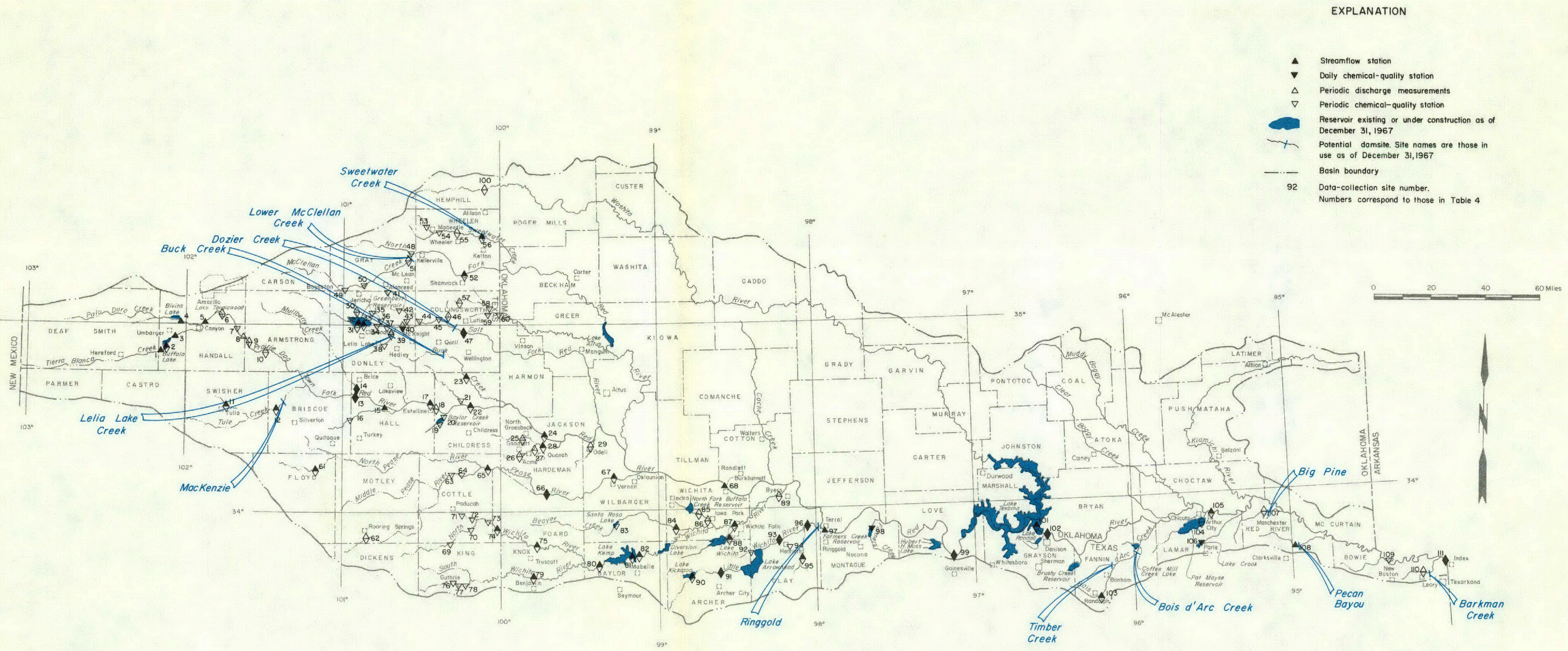

Figure 11

Location of Streamflow and Chemical-Quality Data-Collection Sites, Major Existing Reservoirs, and Potential Reservoir Sites in Texas

Base from U.S. Geological Survey, 1:1,000,000

Figure 12

Dissolved-Solids Concentrations of Surface Water of the Red River Basin

Base from U.S. Geological Survey, 1:1,000,000

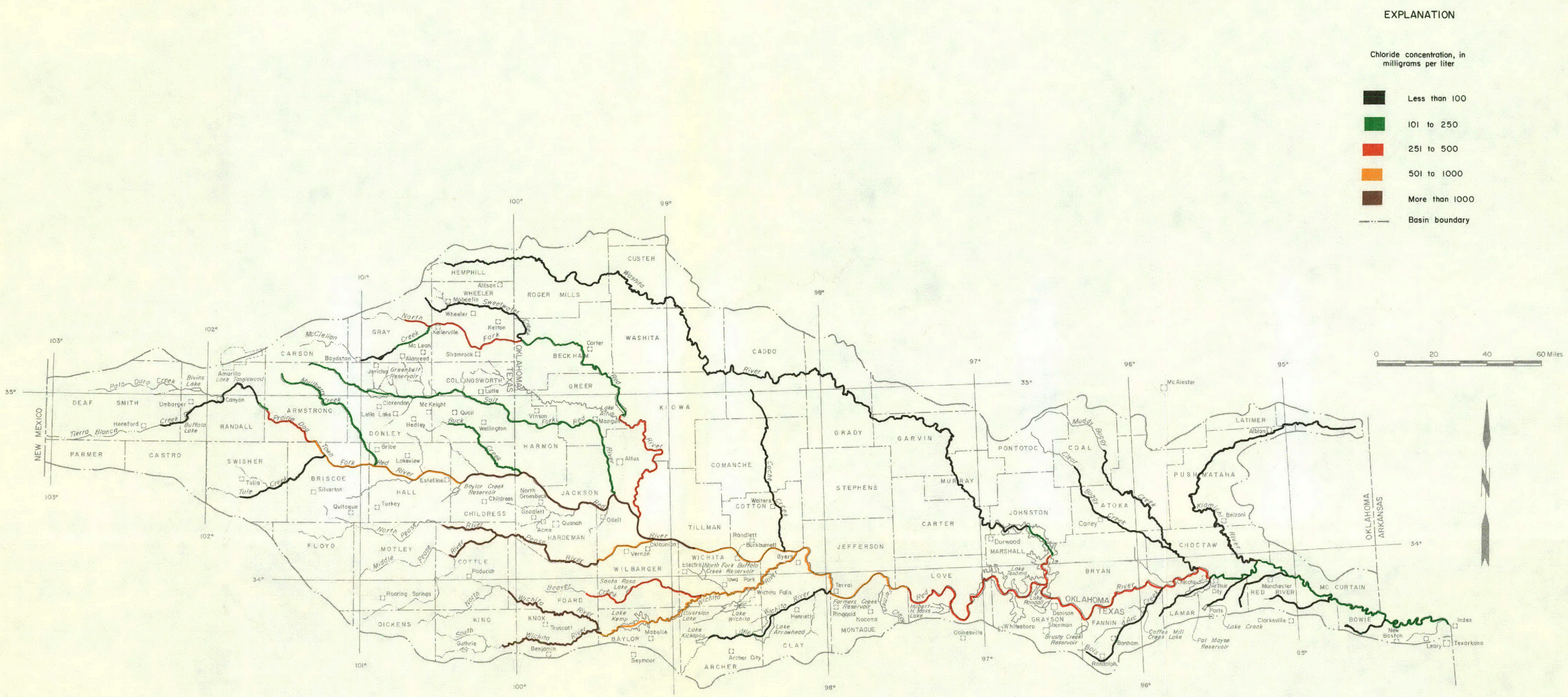

Figure 13
Chloride Concentrations of Surface Water in the Red River Basin

Base from U.S. Geological Survey, 1:1,000,000

Figure 14
Hardness of Surface Water in the Red River Basin

Base from U.S. Geological Survey, 1:1,000,000