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QUANTITY AND CHEMICAL QUALITY OF LOW FLOW IN THE PRAIRIE DOG TOWN FORK RED RIVER NEAR WAYSIDE, TEXAS, FEBRUARY 6-9, 1968

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ABSTRACT

During the period February 6-9, 1968, water discharge in the Prairie Dog Town Fork Red River increased, in a downstream direction, from 0.19 cfs (cubic feet per second) at a point 1 mile below Lake Tanglewood (site 1) to 2.11 cfs near Wayside, Texas (site 69), a river distance of 40.2 miles. The discharge measurements show five reaches had significant gains, four had significant losses, three reaches had no flow, and numerous reaches had smaller gains and losses between individual sites. There were no releases from Lake Tanglewood during this period. The quality of water deteriorated progressively downstream. Dissolved solids increased from 468 mg/l (milligrams per liter) at site 1 to 8,330 mg/l at site 69. The chloride concentration increased from 28 mg/l to 3,300 mg/l.

QUANTITY AND CHEMICAL QUALITY OF LOW FLOW IN THE PRAIRIE DOG TOWN FORK RED RIVER NEAR WAYSIDE, TEXAS, FEBRUARY 6-9, 1968

PURPOSE AND SCOPE OF THE STUDY

This investigation was made under a cooperative agreement with the Texas Water Development Board to determine the changes in quantity and chemical quality of low flow in a 40.2-mile reach of the Prairie Dog Town Fork Red River from one mile below Lake Tanglewood to the U.S. Geological Survey stream-gaging and chemical-quality station, Prairie Dog Town Fork Red River near Wayside.

Discharge measurements were made at 27 sites on the Prairie Dog Town Fork Red River and at eight sites on tributaries. Water samples were collected at 21 sites on the Prairie Dog Town Fork Red River and at four sites on tributaries. In addition, six observations of no flow were made on the river and 28 observations of no flow were made on tributaries. During the period of this investigation there were no releases or outflow from Lake Tanglewood. Field specific conductance and temperature of the water were obtained at all measuring sites; changes in the field specific conductance were used to determine the best locations to collect samples for chemical analyses.

DESCRIPTION OF THE BASIN

The reach of the Prairie Dog Town Fork Red River investigated during this study is in the High Plains physiographic section of north Texas (Figure 2). Altitudes range from about 3,400 feet above mean sea level at Lake Tanglewood to about 2,465 feet above mean sea level at the stream-gaging and chemical-quality station near Wayside, Texas. As a result of erosion of a fluviatile plain, a steep narrow canyon (Palo Duro Canyon) has been formed by the river in the study reach.

GEOLOGIC UNITS AND THEIR WATER-BEARING CHARACTERISTICS

The geologic units that crop out within the study reach are the Whitehorse Group of Permian age, the Dockum Group of Triassic age, the Ogallala Formation of Tertiary age, and alluvium of Quaternary age (Figure 2).

Whitehorse Group

The Whitehorse Group of Permian age is the oldest geologic unit in the area. The group is composed mostly of brick-red shale and beds of sandstone, gypsum, and dolomite. In general, the upper part of the Whitehorse contains mostly sandy shale and beds of sandstone, while the lower part of the unit contains mostly shale and fairly thick beds of gypsum. The thickness of the Whitehorse is estimated to be about 500 feet.

No springs were observed in rocks of the Whitehorse Group; however, along the main stem and along a few tributaries, moist areas with salt crusts were observed near the base of sandstone and gypsum beds. Along some parts of the study reach, the sandstone and gypsum beds are probably in hydraulic continuity with the overlying alluvium. After prolonged periods of rainfall, water is probably discharged from the gypsum and sandstone beds to the main and tributary channels.

Dockum Group

The Dockum Group of Triassic age unconformably overlies the Whitehorse Group. The upper part of the Dockum is composed of alternating sandstone and shale beds; the lower part is composed of varicolored shales. The sandstone beds in the upper part of the unit are usually massive, sometimes as much as 30 feet thick, and may grade locally into conglomerate beds. The sandstone or conglomerate beds are separated by gray or reddish shale which erodes to form the steep ledge walls along

the canyon. The lower part of the Dockum is composed of varicolored shales that are maroon or purple near the top and gray or white near the base. In general, the Dockum Group can be distinguished easily from the underlying brick-red Permian rocks. The maximum thickness of the Dockum is estimated to be about 400 feet.

Springs were observed at the base of most of the massive sandstone beds, particularly at the base of the sandstone and conglomerate beds that are present near the contact with the lower varicolored shale unit. Some of the water being discharged from the Dockum is probably derived from leakage from the overlying Ogallala Formation.

Ogallala Formation

The Ogallala Formation of Tertiary age unconformably overlies the Dockum Group. The Ogallala is composed of partly consolidated beds of sand, silt, clay, gravel, and caliche. Massive caliche beds form a caprock along the canyon walls. The thickness of the Ogallala is estimated to be about 250 feet.

In the High Plains, ground water is obtained in large quantities from sand and gravel beds in the Ogallala Formation. Most of the base flow of Prairie Dog Town Fork Red River above Lake Tanglewood is derived from springs in the Ogallala Formation. No springs were observed in the Ogallala along the main channel in the study reach, but numerous springs are present near the headwaters of some of the larger tributaries.

Quaternary Alluvium

The alluvium of Quaternary age consists of channel fill and floodplain deposits that overlie rocks of the Dockum and Whitehorse Groups. This alluvium consists of well to poorly sorted deposits of sand, silt, clay, gravel, and boulders. These deposits are composed of coarse material in the upper part of the study reach and finer material in the lower part. The thickness of the alluvium varies from zero in the uppermost part of the reach at site 1 to approximately 35 feet in the extreme lower part of the study reach at the stream-gaging station.

Seepage was evident along some of the banks, indicating that water was probably moving through the alluvial deposits toward the stream channel. However, only a few springs were observed in the alluvium.

CONDITIONS OF FLOW

Climatic conditions for determining gains or losses of streamflow were favorable during the period February 6-9, 1968. The study was preceded by about 13 days without rainfall. Water temperatures varied from 3°C (38°F) to 17°C (62°F), and streamflow at the stream-gaging station near Wayside remained at a constant discharge of 2.11 cfs (cubic feet per second).

CHEMICAL QUALITY OF THE WATER

The water of Prairie Dog Town Fork Red River 1 mile below Lake Tanglewood (site 1) contained 468 mg/l (milligrams per liter) dissolved solids and 28 mg/l chloride. The quality of the river water deteriorated progressively downstream, with dissolved solids increasing to 2,600 mg/l and chloride to 50 mg/l at mile 19.0 (site 43). At mile 0 (site 69), the dissolved solids increased to 8,330 mg/l and chloride to 3,300 mg/l.

The water in the tributary streams in the upper reaches was of good quality, but the amount of flow was not enough to significantly influence the quality in the main stem. The tributaries in the lower reaches contributed water of about the same quality as the main stem. Chemical-quality and discharge data are shown on Figure 1. Chemical analyses are given in Table 2.

Flow derived from rocks of the Dockum Group contained mostly magnesium and bicarbonate as the major ions. Flow derived from rocks of the Whitehorse Group contained calcium and sulfate as the major ions.

GAINS AND LOSSES IN FLOW

During this investigation the overall gain in flow throughout the total reach of 40.2 miles was 1.92 cfs (Table 1). Between individual sites, the discharge measurements show five reaches had significant gains, four had significant losses, three reaches had no flow, and numerous reaches had smaller gains and losses. These gains and losses are summarized in Table 3.

Losses in streamflow are generally attributable to losses of water into the alluvial deposits in the river channel. Gains in streamflow are attributed to effluent ground water, spring flow, and tributary inflow. A distinct change in the chemical quality without a corresponding change in discharge indicates an interchange of surface water and ground water.

Most of the low flow of the Prairie Dog Town Fork Red River above Lake Tanglewood is derived from springs in the Ogallala Formation. No springs were observed in the Ogallala along the main channel of this study area, but numerous springs are present near the headwaters of some of the tributaries. Springs were observed at the base of most of the sandstone beds of the Dockum Group, and some of the water being discharged is probably leakage from the overlying Ogallala Formation. Few springs were observed in the alluvium, but seepage along some of the banks indicated that water was moving through the alluvial deposits toward the stream channel.

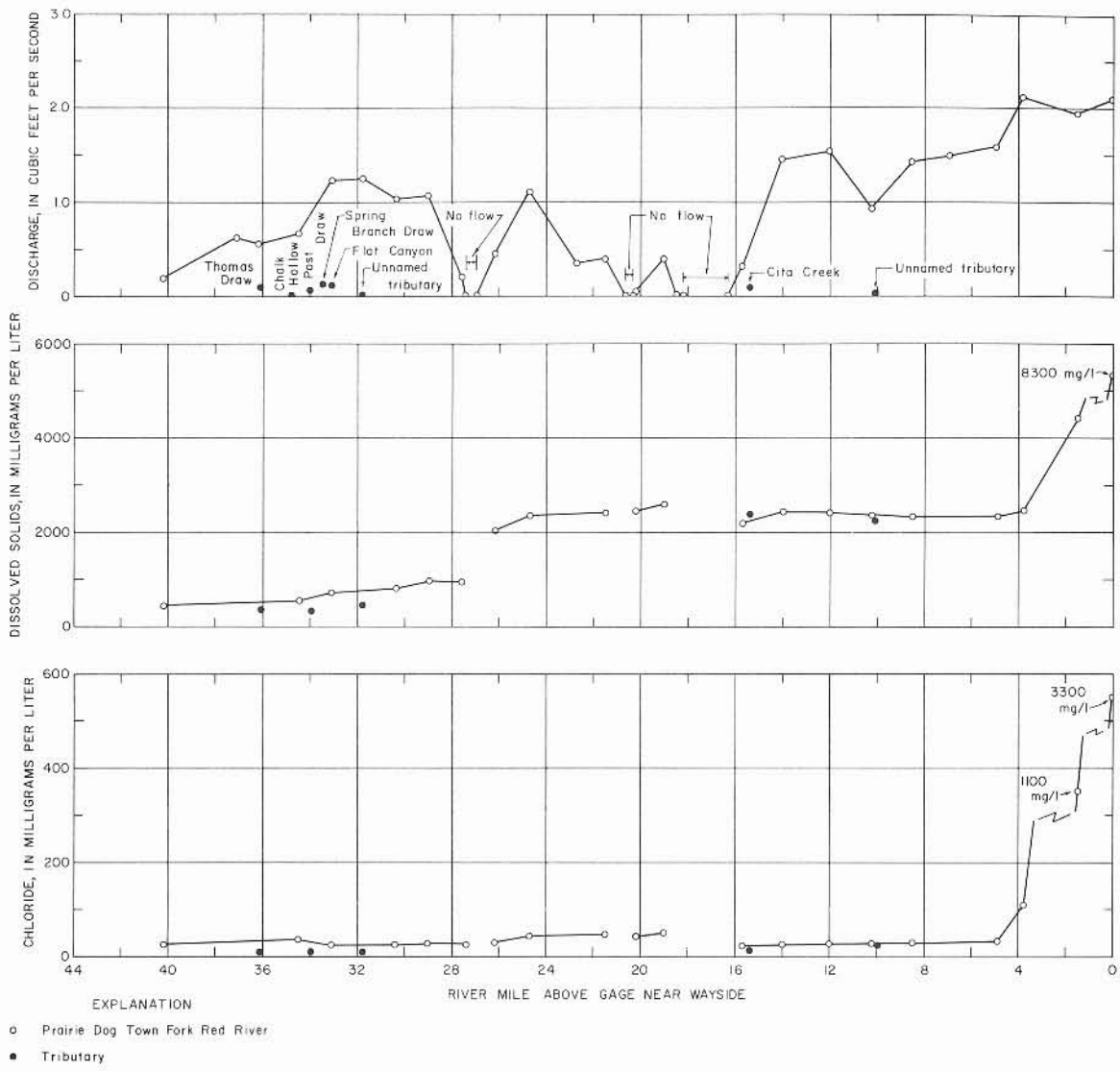

Figure 1.—Water Discharge, and Dissolved-Solids and Chloride Concentrations, Prairie Dog Town Fork Red River and Tributaries

Table 1.--Discharge Measurements, Prairie Dog Town Fork Red River and Tributaries

Site	Date (1968)	Stream	Location	a/River mile	Water temp. °C	Water temp. °F	Discharge in cfs: Main stream	Discharge in cfs: Tributary	Remarks
1	Feb. 6	Prairie Dog Town Fork Red River	Lat 35°02'17", long 101°45'51", 1 mile below Lake Tanglewood dam.	40.2	7	44	0.19	--	Channel is sandstone.
2	6	do	Lat 35°03'09", long 101°44'36".	37.1	7	44	.62	--	Channel is sand and gravel.
3	6	do	Lat 35°03'29", long 101°44'27", 300 ft above Thomas Draw.	36.2	7	44	.56	--	Channel is sand and gravel with boulders.
4	6	Thomas Draw	Lat 35°03'34", long 101°44'23", at mouth.	b/36.1	10	50	--	0.11	Do.
5	6	Windmill Draw	Lat 35°03'20", long 101°43'38", at mouth.	b/35.3	--	--	--	0	
6	6	Chalk Hollow	Lat 35°03'10", long 101°43'24", about 100 ft above mouth.	b/34.8	11	52	--	.01	Do.
7	6	Nameless Draw	Lat 35°02'52", long 101°43'28", at mouth.	b/34.6	--	--	--	0	
8	6	Prairie Dog Town Fork Red River	Lat 35°02'52", long 101°43'22", downstream from Nameless Draw	34.5	10	50	.67	--	Channel is sand and gravel with large boulders.
9	6	Post Draw	Lat 35°02'39", long 101°43'03", at mouth.	b/34.0	9	49	--	.07	Do.
10	6	Spring Branch Draw	Lat 35°02'16", long 101°43'05", about 1,000 ft above mouth.	b/33.5	12	54	--	.13	Do.
11	6	Flat Canyon	Lat 35°02'11", long 101°42'35", at mouth.	b/33.1	10	50	--	.12	Channel is sand and gravel.
12	6 & 7	Prairie Dog Town Fork Red River	Lat 35°02'07", long 101°42'37",	b/33.1	10 6	50 42	1.29 1.24	-- --	Channel is sand and gravel with some boulders. Measurement on Feb. 7 made for correlation with measurement on previous day.
13	7	Dugout Draw	Lat 35°01'58", long 101°42'35", at mouth.	b/32.9	--	--	--	0	
14	7	Blue Spring Canyon	Lat 35°01'47", long 101°42'03", at mouth.	b/32.3	--	--	--	0	
15	7	Prairie Dog Town Fork Red River	Lat 35°01'24", long 101°42'06".	31.8	6	42	1.25	--	Channel is sand and gravel with some shale and gypsum fragments.
16	7	Unnamed tributary to Prairie Dog Town Fork Red River	Lat 35°01'21", long 101°42'05", upstream from Stub Draw.	b/31.8	3	38	--	e/.01	Channel is sand and gravel.
17	7	Deep Canyon	Lat 35°01'04", long 101°41'50", at mouth.	b/31.3	--	--	--	0	
18	7	Little Draw	Lat 35°00'49", long 101°41'39", at mouth.	b/30.9	--	--	--	0	

See footnotes at end of table.

Table 1.--Discharge Measurements, Prairie Dog Town Fork Red River and Tributaries --Continued

Site	Date (1968)	Stream	Location	a/River mile	Water temp. °C	Water temp. °F	Discharge in cfs: Main stream	Discharge in cfs: Tributary	Remarks
19	Feb. 7	Forked Draw	Lat 35°00'42", long 101°41'34", at mouth.	b/30.7	--	--	--	0	
20	7	Prairie Dog Town Fork Red River	Lat 35°00'28", long 101°41'26".	30.4	7	44	1.03	--	Channel is gravel with some large boulders.
21	7	Seep Canyon	Lat 34°59'32", long 101°40'48", at mouth.	b/29.1	--	--	--	0	
22	7	Prairie Dog Town Fork Red River	Lat 34°59'29", long 101°40'50", upstream from Cooley Draw.	29.0	9	48	1.07	--	Channel is sand and gravel with boulders.
23	7	Cooley Draw	Lat 34°59'26", long 101°40'51", at mouth.	b/28.9	--	--	--	0	
24	7	North Spur	Lat 34°58'48", long 101°40'28", at mouth.	b/27.9	--	--	--	0	
25	7	Brushy Draw	Lat 34°58'41", long 101°40'25", at mouth.	b/27.8	--	--	--	0	
26	7	Prairie Dog Town Fork Red River	Lat 34°58'31", long 101°40'25".	27.6	13	56	.21	--	Channel is silt and sand with gravel banks.
27	7	do	Lat 34°58'25", long 101°40'27".	27.5	--	--	0	--	
28	7	Timber Creek	Lat 34°58'12", long 101°40'37", at mouth.	b/27.2	--	--	--	0	
29	7	Prairie Dog Town Fork Red River	Lat 34°58'01", long 101°40'29".	27.0	--	--	0	--	Flow begins just below this site.
30	7	South Brushy Draw	Lat 34°58'08", long 101°40'13", at mouth.	b/26.8	--	--	--	0	
31	7	Prairie Dog Town Fork Red River	Lat 34°57'53", long 101°40'17".	26.2	12	54	.46	--	Channel is silt, sand, and gravel, with considerable gypsum fragments.
32	7	Burnt Draw	Lat 34°57'36", long 101°40'09", at mouth.	b/ 25.7	--	--	--	0	
33	7	Sunday Creek	Lat 34°57'28", long 101°40'20", at mouth.	b/25.6	--	--	--	0	
34	7	Prairie Dog Town Fork Red River	Lat 34°56'52", long 101°39'48".	24.7	14	57	1.11	--	Channel is sand and gravel.
35	7	Capitol Peak Canyon	Lat 34°56'52", long 101°39'50", at mouth.	b/24.6	--	--	--	0	
36	7	Red Canyon	Lat 34°56'42", long 101°39'40", at mouth.	b/24.4	--	--	--	0	
37	7	Prairie Dog Town Fork Red River	Lat 34°56'10", long 101°38'34".	22.7	14	57	.35	--	Channel is sand and gravel, some salt deposits on gravel.
38	7	do	Lat 34°55'48", long 101°37'34", above Tub Spring Draw.	21.5	13	55	.40	--	Channel is silt, sand, gravel, and some boulders.
39	7	Tub Springs Draw	Lat 34°55'50", long 101°37'27", at mouth.	b/21.5	--	--	--	0	
40	8	Prairie Dog Town Fork Red River	Lat 34°55'18", long 101°36'58".	20.6	--	--	0	--	No flow in channel at this point; streambed is composed of sand and gravel.

See footnotes at end of table.

Table 1.--Discharge Measurements, Prairie Dog Town Fork Red River and Tributaries --Continued

Site	Date (1968)	Stream	Location	a/River mile	Water temp. °C	Water temp. °F	Discharge in cfs: Main stream	Discharge in cfs: Tributary	Remarks
41	Feb. 8	Prairie Dog Town Fork Red River	Lat 34°55'25", long 101°36'40".	20.3	--	--	0	--	Channel is sand and gravel. Flow begins just downstream.
42	8	do	Lat 34°55'23", long 101°36'37".	20.2	13	55	.05	--	Channel is sand and gravel with some boulders.
43	8	do	Lat 34°54'44", long 101°36'04".	19.0	11	52	.40	--	Channel is sand and gravel.
44	8	Bull Canyon	Lat 34°54'37", long 101°35'46", at mouth.	b/18.9	--	--	--	0	
45	8	Prairie Dog Town Fork Red River	Lat 34°54'22", long 101°35'52", at jeep crossing.	18.5	12	54	e/.01	--	Channel is sand and gravel with boulders.
46	8	do	Lat 34°54'14", long 101°35'53".	18.2	--	--	0	--	No flow in channel at this point. Streambed is sand and gravel.
47	8	McFarland Creek	Lat 34°54'03", long 101°35'41", at mouth.	b/18.1	--	--	--	0	
48	8	Prairie Dog Town Fork Red River	Lat 34°53'13", long 101°36'19".	16.3	--	--	0	--	Flow begins just below this point.
49	8	do	Lat 34°52'44", long 101°36'15".	15.7	14	58	.32	--	Channel is sand with some gravel.
50	8	Cita Creek	Lat 34°52'53", long 101°36'33", at jeep crossing about 2,000 ft above mouth.	--	17	62	--	e/.09	Channel is sand.
51	8	do	Lat 34°52'38", long 101°36'21", at mouth.	b/15.4	--	--	--	0	
52	8	Cobb Canyon	Lat 34°52'17", long 101°35'30", at mouth.	b/ b/14.5	--	--	--	0	
53	8	Prairie Dog Town Fork Red River	Lat 34°52'14", long 101°34'53".	14.0	17	62	1.45	--	Channel is sand and gravel.
54	8	Leigh Arroyo	Lat 34°51'22", long 101°33'38", at mouth.	b/12.1	--	--	--	0	
55	8	Prairie Dog Town Fork Red River	Lat 34°51'16", long 101°33'17".	12.0	14	58	1.54	--	Do.
56	8	Old Home Draw	Lat 34°51'12", long 101°32'33", at mouth.	b/11.3	--	--	--	0	
57	8	Prairie Dog Town Fork Red River	Lat 34°51'33", long 101°31'43".	10.2	13	56	.93	--	Channel is silt, sand, and gravel.
58	8	Unnamed tributary to Prairie Dog Town Fork Red River.	Lat 34°51'37", long 101°31'54", at mouth and 1.0 mile above Pony Spring Creek.	b/10.1	14	58	--	e/.03	Channel is silt and sand.
59	8	Pony Spring Creek	Lat 34°51'52", long 101°31'07", at mouth.	b/9.5	--	--	--	0	
60	8	McGehee Hollow	Lat 34°51'32", long 101°30'34", at mouth.	b/9.0	--	--	--	0	
61	8	Prairie Dog Town Fork Red River	Lat 34°51'48", long 101°30'01", at east line of Harrel Ranch.	8.5	10	50	1.43	--	Channel is silt and sand.

See footnotes at end of table.

Table 1.--Discharge Measurements, Prairie Dog Town Fork Red River and Tributaries --Continued

Site	Date (1968)	Stream	Location	a/River mile	Water temp. °C	Water temp. °F	Discharge in cfs: Main stream	Discharge in cfs: Tributary	Remarks
62	Feb. 8	Prairie Dog Town Fork Red River	Lat 34°51'54", long 101°29'05".	6.9	8	46	1.49	--	Channel is silt and sand with some gravel.
63	9	do	Lat 34°51'52", long 101°28'23".	4.9	9	48	1.60	--	Do.
64	9	Dry Creek	Lat 34°52'11", long 101°28'07", at mouth.	b/4.5	--	--	--	--	Do.
65	9	Prairie Dog Town Fork Red River	Lat 34°51'37", long 101°27'27".	3.8	12	54	2.12	--	Channel is sand and gravel.
66	9	do	Lat 34°50'49", long 101°26'02".	1.5	13	55	1.95	--	Channel is sand with some gravel. There are salt deposits on gravel along banks.
67	9	Happy Canyon	Lat 34°50'44", long 101°26'05", at mouth.	b/1.5	--	--	--	0	
68	9	Salt Fork	Lat 34°50'51", long 101°25'09", at mouth.	b/ .6	--	--	--	0	
69	9	Prairie Dog Town Fork Red River	Lat 34°50'15", long 101°24'50", at U.S.G.S. gaging station near Wayside, Tex. on Highway 284.	0	13	56	2.11	--	Channel is silt and sand with some gravel. There are salt deposits on gravel along banks.

a/ River miles above gage near Wayside.
b/ River miles on Prairie Dog Town Fork Red River at mouth of tributary.
e/ Discharge estimated.

Table 2.--Chemical Analyses of Water From the Prairie Dog Town Fork Red River and Tributaries

(Results in milligrams per liter except as indicated)

SITE	STREAM	DATE OF COLLECTION (1968)	DISCHARGE (CFS)	SILICA (SiO_2)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	BORON (B)	DISSOLVED SOLIDS (CALCULATED)	HARDNESS AS $CaCO_3$		SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS AT 25°C)	pH
																CALCIUM, MAGNESIUM	NONCARBONATE			
1	Prairie Dog Town Fork Red River	Feb. 6	0.19	31	35	53	63	5.2	424	39	28	5.7	0.2	0.19	468	306	0	1.6	783	8.2
4	Thomas Draw	do	.11	48	39	34	35	4.9	316	39	11	3.8	1.4	--	371	238	0	1.0	578	7.9
8	Prairie Dog Town Fork Red River	do	.67	--	--	--	--	--	340	76	38	--	--	--	520a/	280	2	--	772	7.8
9	Post Draw	do	.07	51	30	24	40	4.9	262	26	12	3.6	4.5	--	325	174	0	1.3	491	8.1
12	Prairie Dog Town Fork Red River	do	1.29	30	109	33	81	5.3	266	304	24	3.8	.7	--	722	408	190	1.7	1,020	7.6
16	Unnamed tributary	Feb. 7	.01	--	--	--	--	--	426b/	29	9.2	--	--	--	490a/	--	--	--	731	8.5
20	Prairie Dog Town Fork Red River	do	1.03	28	123	36	87	5.4	242	380	26	3.7	.3	--	808	455	256	1.8	1,140	7.5
22	do	do	1.07	--	--	--	--	--	158	566	28	--	--	--	907a/	640	510	--	1,300	7.4
26	do	do	.21	27	146	40	89	5.5	123	550	25	3.6	0	--	946	529	428	1.7	1,270	7.7
31	do	do	.46	28	425	68	98	6.3	196	1,310	29	3.3	.3	--	2,060	1,340	1,180	1.2	2,250	7.4
34	do	do	1.11	--	--	--	--	--	132	1,550	42	--	--	--	2,370	1,600	1,490	--	2,610	7.5
38	do	do	.40	--	--	--	--	--	112	1,610	47	--	--	--	2,410a/	1,630	1,540	--	2,680	7.6
42	do	Feb. 8	.05	--	--	--	--	--	138	1,620	42	--	--	--	2,460a/	1,560	1,450	--	2,730	7.6
43	do	do	.40	42	498	92	135	6.6	107	1,720	50	2.6	0	--	2,600	1,620	1,530	1.5	2,820	7.5
49	do	do	.32	--	--	--	--	--	120	1,460	26	--	--	--	2,200a/	1,440	1,340	--	2,450	7.5
50	Cita Creek	do	.09	23	578	38	78	6.0	160	1,580	14	2.0	.6	--	2,400	1,600	1,470	.9	2,450	7.3
53	Prairie Dog Town Fork Red River	do	1.45	24	508	75	113	5.5	116	1,630	26	1.9	0	--	2,440	1,580	1,480	1.2	2,640	7.4
55	do	do	1.54	--	--	--	--	--	140	1,650	28	--	--	--	2,430a/	1,640	1,530	--	2,700	7.4
57	do	do	.93	--	--	--	--	--	119	1,620	28	--	--	--	2,380a/	1,600	1,500	--	2,640	7.5
58	Unnamed tributary	do	.03	26	428	84	126	5.4	164	1,500	25	2.2	.1	--	2,280	1,410	1,280	1.5	2,540	7.5
61	Prairie Dog Town Fork Red River	do	1.43	--	--	--	--	--	113	1,610	28	--	--	--	2,330a/	1,500	1,410	--	2,590	7.6
63	do	Feb. 9	1.60	--	--	--	--	--	126	1,540	33	--	--	--	2,350a/	1,460	1,360	--	2,610	7.5
65	do	do	2.12	26	440	92	177	6.0	136	1,560	110	4.2	.3	--	2,480	1,480	1,360	2.0	2,860	7.5
66	do	do	1.95	26	465	102	868	12	102	1,800	1,100	--	.6	.55	4,420	1,580	1,500	9.5	5,790	7.5
69	do	do	2.11	27	545	119	2,240	28	130	2,010	3,300	--	--	--	8,330	1,850	1,740	23	12,500	7.3

a/ Computed from specific conductance.
b/ Includes the equivalent of 16 mg/l carbonate (CO_3).

Table 3.--Gains and Losses in Twelve Subreaches of the Prairie Dog Town Fork Red River

SUBREACH	RIVER MILES[a]	CHANGE IN DISCHARGE	NUMBER OF MILES IN SUBREACH	REMARKS
Site 1 to site 12	40.2 to 33.1	1.10 cfs gain	7.1	There is a general gain throughout this reach with flow increasing from 0.19 cfs at site 1 to 1.29 cfs at site 12. Tributary flow contributed 0.44 cfs; the additional increase can be attributed to seeps and springs along the main stem. Dissolved solids increased from 468 mg/l at mile 40.2 (site 1) to 722 mg/l at mile 33.1 (site 12) as a result of flow coming in contact with rocks of the Whitehorse Group.
Site 12 to site 27	33.1 to 27.5	1.29 cfs loss	5.6	Loss in this reach is due to sand and gravel deposits in the channel. Dissolved solids increased from 722 mg/l at mile 33.1 to 946 mg/l at mile 27.6 (site 26).
Site 27 to site 29	27.5 to 27.0	No flow	0.5	No flow in this reach. Channel is composed of large deposits of sand and gravel.
Site 29 to site 34	27.0 to 24.7	1.11 cfs gain	2.3	The gain probably results from water returning to the surface from gravel and sand deposits in the channel. Dissolved solids increased from 2,060 mg/l at mile 26.2 (site 31) to 2,370 mg/l at mile 24.7 (site 34). This increase in dissolved solids resulted from flow coming in contact with gypsum beds in the channel.
Site 34 to site 40	24.7 to 20.6	1.11 cfs loss	4.1	This loss results from water seeping into alluvium and into cavities in the gypsum beds within the channel. Dissolved solids increased from 2,370 mg/l at mile 24.7 (site 34) to 2,410 mg/l at mile 21.5 (site 38). This increase resulted from solution of minerals in the alluvium and the Whitehorse Group.

Table 3.--Gains and Losses in Twelve Subreaches of the Prairie Dog Town Fork Red River--Continued

SUBREACH	RIVER MILES[a]	CHANGE IN DISCHARGE	NUMBER OF MILES IN SUBREACH	REMARKS
Site 40 to site 41	20.6 to 20.3	No flow	0.3	No flow in this reach. Channel is composed of sand and gravel.
Site 41 to site 43	20.3 to 19.0	0.40 cfs gain	1.3	The gain in this reach is attributed to water returning to the surface from the alluvium and underlying gypsum beds. The dissolved solids increased from 2,460 mg/l at mile 20.2 (site 42) to 2,600 mg/l at mile 19.0 (site 43). The increase is due to flow coming in contact with gypsum beds in the channel.
Site 43 to site 46	19.0 to 18.2	0.40 cfs loss	0.8	This loss results from surface flow returning to alluvial deposits and gypsum cavities underlying the channel.
Site 46 to site 48	18.2 to 16.3	No flow	1.9	No flow in this reach. Channel is composed of sand and gravel.
Site 48 to site 55	16.3 to 12.0	1.54 cfs gain	4.3	This gain probably results from water returning to the surface from the underlying gypsum beds and alluvial deposits.
Site 55 to site 57	12.0 to 10.2	0.61 cfs loss	1.8	This loss results from water flowing underground into the alluvial deposits and gypsum cavities.
Site 57 to site 69	10.2 to 0			This gain results from seeps along thick gypsum beds which crop out along this reach. The dissolved solids increased from 2,380 mg/l at mile 10.2 (site 57) to 8,330 mg/l at mile 0 (site 69).

[a] River miles above gage near Wayside.