WATER-QUALITY CONDITIONS AND STREAMFLOW GAIN AND LOSS OF THE SOUTH PRONG OF SPAVINAW CREEK BASIN, BENTON COUNTY, ARKANSAS

by Robert L. Joseph and W. Reed Green

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
yard (yd)	0.9144	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot per minute (ft/min)	0.3048	meter per minute
foot per mile (ft/mi)	0.1894	meter per kilometer
gallon per minute (gal/min)	0.063008	liter per second

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows:

$$°F = 1.8\ °C + 32$$

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

WATER-QUALITY CONDITIONS AND STREAMFLOW GAIN AND LOSS OF THE SOUTH PRONG OF SPAVINAW CREEK BASIN, BENTON COUNTY, ARKANSAS

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ABSTRACT

A study of the South Prong of Spavinaw Creek Basin conducted between July 14 and July 23, 1993, described the surface- and ground-water quality of the basin and the streamflow gain and loss. Water samples were collected from 10 sites on the mainstem of the South Prong of Spavinaw Creek and from 4 sites on tributaries during periods of low to moderate streamflow (less than 11 cubic feet per second). Water samples were collected from 4 wells and 10 springs located in the basin.

In 14 surface-water samples, nitrite plus nitrate concentrations ranged from 0.75 to 4.2 milligrams per liter as nitrogen. Orthophosphorus concentrations ranged from 0.03 to 0.15 milligrams per liter as phosphorus. Fecal coliform bacteria counts ranged from 61 to 1,400 colonies per 100 milliliters, with a median of 120 colonies per 100 milliliters. Fecal streptococci bacteria counts ranged from 70 to greater than 2,000 colonies per 100 milliliters with a median of 185 colonies per 100 milliliters. Analysis for selected metals collected at one surface-water site indicates that metals are not present in significant concentrations.

Diel dissolved oxygen concentrations and temperatures were measured at an upstream and downstream site on the mainstem of the stream. At the upstream site, dissolved oxygen concentrations ranged from 7.2 to 8.3 milligrams per liter and temperatures ranged from 15.5 to 17.0 °C. Dissolved oxygen concentrations were higher and temperature values were lower at the upstream site, which is located close to two springs that produce all of the flow at that site.

Dissolved nitrite plus nitrate was present in all four wells sampled in the basin with concentrations ranging from 0.04 to 3.5 milligrams per liter as nitrogen. Orthophosphorus was present in concentrations ranging from less than 0.01 to 0.07 milligrams per liter as phosphorus. Volatile organic compound analyses in two wells indicate that toluene was present in both wells and chloroform was present in one well. All other volatile organic compounds were found to be below the reporting limits. Analysis for common constituents and selected metals indicated that fluoride concentrations in one well exceeded the U.S. Environmental Protection Agency's primary maximum contamination levels for drinking water.

Analyses of water samples collected from springs indicate that nitrite plus nitrate concentrations ranged from 0.43 to 3.9 milligrams per liter as nitrogen. Dissolved ammonia plus organic nitrogen concentrations ranged from less than 0.20 to 0.64 milligrams per liter at nitrogen. Orthophosphorus concentrations ranged from 0.02 to 0.09 milligrams per liter as phosphorus. Fecal coliform bacteria counts ranged from less than 3 to more than 2,000 colonies per 100 milliliters, with a median of 370 colonies per 100 milliliters. Fecal streptococci bacteria counts ranged from less than 4 to greater than 2,000 colonies per 100 milliliters with a median of 435 colonies per 100 milliliters.

Streamflow in nine reaches of the mainstem increased an average of 20 percent. Six losing reaches were identified during the study of the South Prong of Spavinaw Creek Basin, one located on the mainstem and the other five located on tributaries to the mainstem.

INTRODUCTION

The purpose of this report is to present physical, nutrient, bacteriological, common constituent, metal and volatile organic compound data collected at various surface- and ground-water sites in the basin and to present discharge data collected along reaches of the South Prong of Spavinaw Creek and its tributaries. This report was prepared by the U.S. Geological Survey (USGS) in cooperation with the Arkansas Department of Pollution Control and Ecology.

The authors wish to thank land owners Jack Elders, Linda Webb, Orlando Martinez and Virgil Breisacher for granting permission and assistance in sampling of their wells and springs.

DESCRIPTION OF STUDY AREA

The South Prong of Spavinaw Creek in northwestern Arkansas drains an area of 17.1 mi^2 (Sullavan and Terry, 1970), and flows in a northwesterly direction through Benton County (fig. 1) in the Springfield Plateau physiographic section (Fenneman, 1938). The Springfield Plateau topography is characterized by gentle to moderate slopes, ranging from 12 to 50 percent. A large part of this section is dissected by streams that form V-shaped valleys. The study area (fig. 2) has a dendritic drainage pattern with land-surface altitudes ranging from approximately 1,065 ft above sea level at the mouth to 1,450 ft above sea level in the southern portion of the study area. The South Prong of Spavinaw Creek has a mean gradient of 25.5 ft/mi with a mean channel width of about 80 ft.

The basin is comprised of 70 percent agricultural land, mostly used to graze cattle and raise chickens, 29 percent forest, and 1 percent urban development. Recent population growth over the last 10 years has resulted in numerous changes in land use. The economic base of Benton County also has changed; farming has become less intensive with increased chicken broiler production becoming the main enterprise within the county (Phillips and Harper, 1977). In 1993, Benton County produced 115,00 cattle, 123,149,000 broilers, 4,531,00 turkeys, and 140,000 swine (Arkansas Agriculture Statistics Service, in press).

The South Prong of Spavinaw Creek Basin was warmer and wetter during the summer of 1993 than normal. Mean annual air temperature in the South Prong of Spavinaw Creek Basin is 58.3 ° F, with an average of 47.6 in. of precipitation annually (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1992). The normal mean air temperature for the months of May through August (1961-1990) is 74.8 °F, however, during this 4-month period in 1993, the mean air temperature was 75.5 °F. The normal precipitation during the months of May through August is 22.8 in., however, 28.5 inches of precipitation was recorded during this period in 1993 (Charles McDonald, National Weather Service Forecast Office, written and oral commun., 1993).

The surficial geology of the South Prong of Spavinaw Creek Basin consists of Mississippian age rocks. The largest portion of the basin lies on the Boone Formation. The Boone Formation predominates and is about 325 ft thick in this area (Freiwald, 1987). The Boone Formation is comprised of limestone, chert, and minor beds of shale and sandstone (Frezon and Glick, 1959). Residual cherty rubble yields 2 to 5 gal/min to wells, however many large springs and wells tap large solution channels, which may yield more than 25 gal/min (Lamonds, 1972). The movement of ground water along fractures and bedding planes in this formation produces abundant caves, solution channels, and sinkholes.

DATA COLLECTION METHODOLOGY

Ground- and surface-water samples were collected and stream discharge measurements were made within the South Prong of Spavinaw Creek Basin between July 14 and July 23, 1993. The sampling site locations were chosen to provide the best understanding of the existing water-quality and streamflow conditions. Water samples were collected by hand dipping sample collection bottles into the centroid of flow at these sites. Collection, storage, and preservation of samples followed methods outlined by Ward and Harr (1990). Analyses for fecal-coliform and fecal-streptococcal bacteria were performed following methods described by Britton and Greeson (1987). Discharge was measured at numerous locations on the mainstem of the stream and at tributary inflow points during low-flow conditions (no storm runoff). Discharge measurements were made with a current meter following methods described by Buchanan and Sommers (1984). Comparisons of successive downstream discharge measurements were used to determine if the stream reaches were gaining or losing flow. Dissolved oxygen concentrations and temperature data were collected for a 24-hour period on an hourly basis at two sites (SSP-2 and SSP-9) on the mainstem of the stream. Water samples from springs were collected by hand dipping sample collection bottles into the orifice of the spring. Water samples from wells were collected from outside faucets after water lines were purged and prior to any treatment systems.

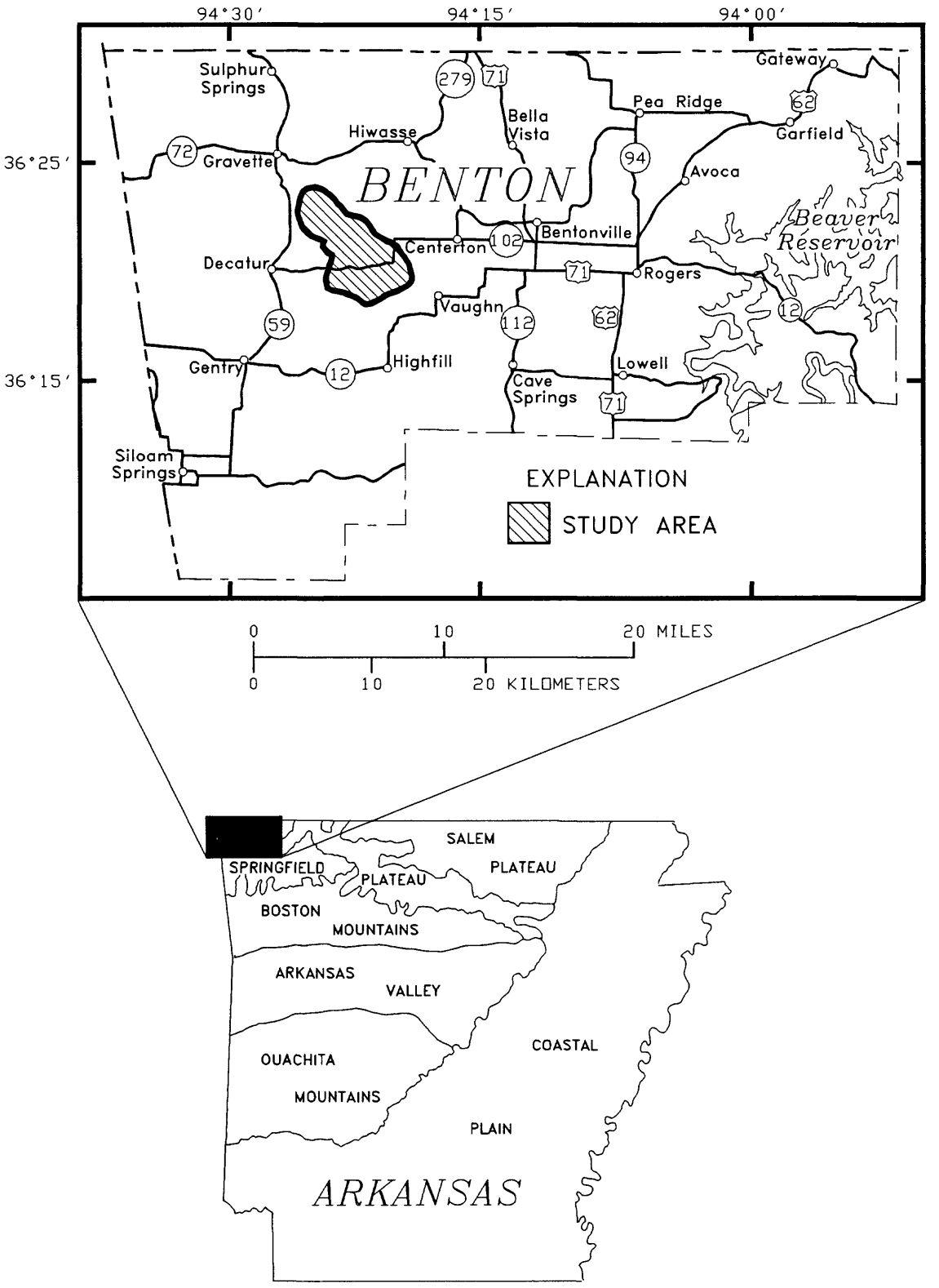

Figure 1.--Location of study area.

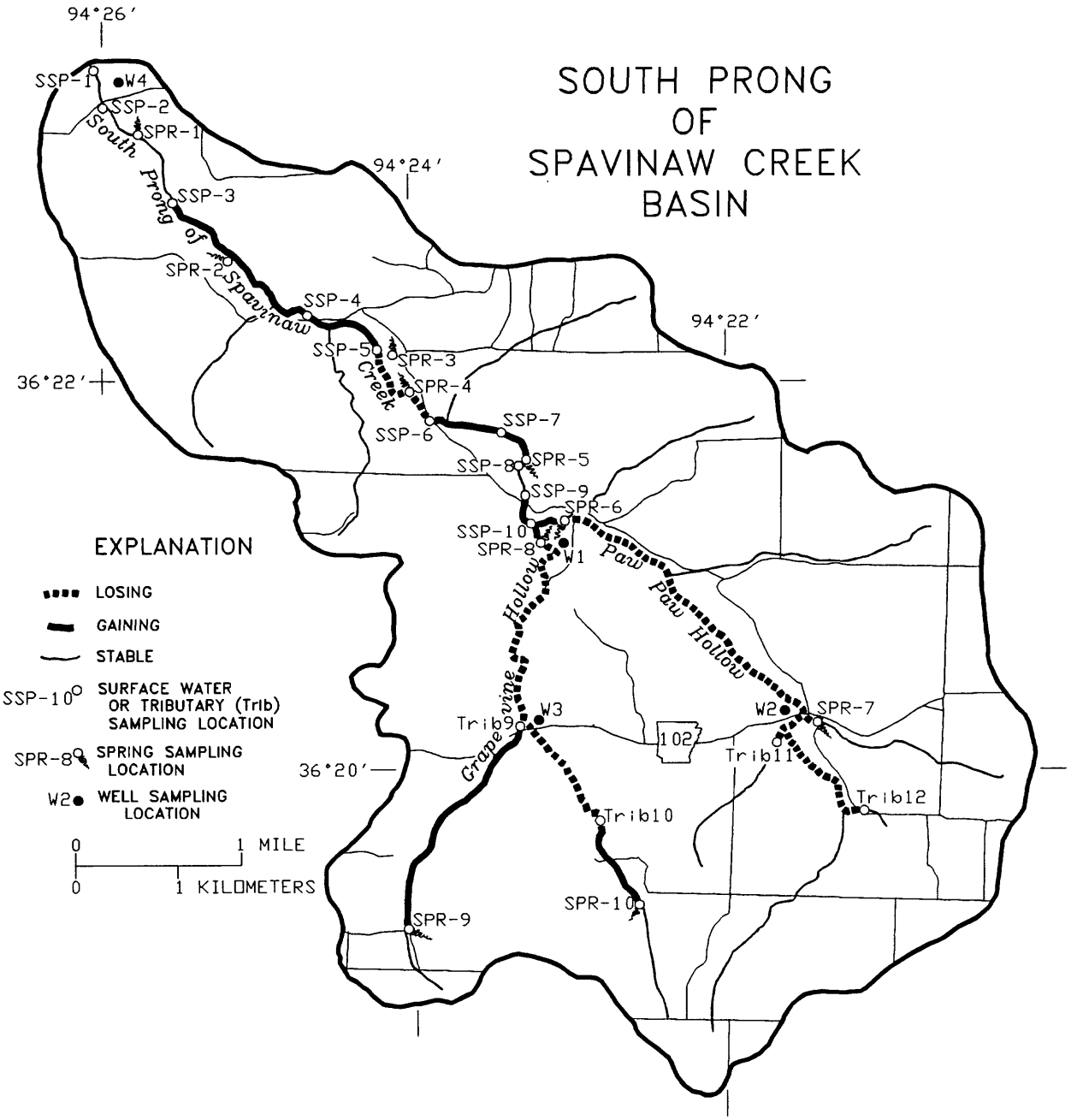

Figure 2.--Location of sampling sites and gaining and losing stream reaches.

SURFACE-WATER QUALITY

Water-quality data was collected at 10 surface-water sites on the mainstem of the South Prong of Spavinaw Creek and at 4 sites on tributaries (table 1) during this study. Specific conductance values ranged from 204 to 296 microsiemens per centimeter at 25.0 °C (µS/cm) (table 2). Dissolved ammonia concentrations for surface-water sites ranged from 0.02 to 0.05 milligrams per liter (mg/L) as nitrogen. Dissolved ammonia plus organic nitrogen values ranged from less than 0.20 to 1.1 mg/L. Dissolved nitrite plus nitrate concentrations for surface-water sites ranged from 0.75 to 4.2 mg/L as nitrogen. Dissolved orthophosphorus concentrations ranged from 0.03 to 0.15 mg/L as phosphorus in surface-water sites. Total phosphorus concentrations ranged from 0.03 to 0.1 mg/L as phosphorus in surface-water sites.

Bacteriological analyses indicate that fecal coliform bacteria counts for surface water sites ranged from 61 to 1,400 colonies per 100 milliliters (cols/100 mL) with a median of 120 cols/100 mL. Fecal streptococci bacteria counts for surface-water sites ranged from 70 to greater than 2,000 cols/100 mL with a median of 185 cols/100 mL.

Samples were analyzed for common constituents and selected metals at one surface-water site (SSP-1). Most concentrations were less than or near the reporting limits (table 3). Calcium, silica, barium, and strontium were present above the reporting limits.

Table 1.–*Surface-water sampling site descriptions in the South Prong of the Spavinaw Creek Basin*

[Station number corresponds to national downstream order number assigned by the U.S. Geological Survey]

Site number	Station number	Station name	Latitude	Longitude	Local site identifier
SSP-1	07191110	South Prong of Spavinaw Creek near Gravette, Arkansas	362344	0942609	20N32W19BBC
SSP-2	07191109	South Prong of Spavinaw Creek southeast of Gravette, Arkansas	362330	0942603	20N32W19CCA
SSP-3	07191108	South Prong of Spavinaw Creek east of Highway 59 near Gravette, Arkansas	362259	0942538	20N32W30ACC
SSP-4	07191106	South Prong of Spavinaw Creek near Decatur, Arkansas	362226	0942446	20N32W32BAA
SSP-5	07191103	South Prong of Spavinaw Creek east of Highway 59 near Decatur, Arkansas	362213	0942417	20N32W32ADB
SSP-6	07191102	South Prong of Spavinaw Creek northeast of Decatur, Arkansas	362153	0942400	20N32W33CBD
SSP-7	07191099	South Prong of Spavinaw Creek east of Decatur, Arkansas	362149	0942332	20N32W33DBC
SSP-8	07191098	South Prong of Spavinaw Creek near Centerton, Arkansas	362144	0942322	20N32W33DCA
SSP-9	07191097	South Prong of Spavinaw Creek west of Highway 102 near Centerton, Arkansas	362130	0942322	19N32W04ABA
SSP-10	07191096	South Prong of Spavinaw Creek north of Highway 102 near Decatur, Arkansas	362121	0942319	19N32W04ADB
Trib- 9	07191089	Tributary 9	362016	0942322	19N32W09DBA
Trib-10	07191092	Tributary 10	361946	0942251	19N32W15BBA
Trib-11	07191070	Tributary 11	362019	0942138	19N32W11BDC
Trib-12	07191067	Tributary 12	361950	0942111	19N32W11DDC

Table 2.--*Discharge and water-quality data for surface-water sites located in the South Prong of Spavinaw Creek Basin*

[Temperature reported to nearest 0.5 degree Celsius; °C, degrees Celsius; five digit numbers in parentheses are STORET parameter codes used for computer storage of data; mm of Hg, millimeters of mercury; ft^3/s, cubic feet per second; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; WH, whole water; FET, fixed endpoint titration; F, field; cols/100 mL, number of colonies per 100 milliliters of sample; <, less than; K, non-ideal count; >, greater than]

Site ID	Date of sample	Time of sample	Water temperature (°C) (00010)	Air pressure (mm of Hg) (00025)	Discharge, instantaneous (ft^3/s) (00061)	Specific conductance (µS/cm at 25 °C) (00095)	Oxygen, dissolved (mg/L) (00300)	pH, field (standard units) (00400)	Alkalinity, WH, FET, F (mg/L as $CaCO_3$) (00410)
SSP-1	7-14-93	0845	19.0	750	10	235	8.1	7.7	94
SSP-2	7-14-93	1000	19.0	750	11	234	8.4	7.6	88
SSP-3	7-14-93	1200	19.0	750	11	235	8.9	7.8	96
SSP-4	7-14-93	1330	17.0	750	9.3	231	8.7	7.5	90
SSP-5	7-20-93	1025	17.0	732	3.9	239	8.2	7.8	96
SSP-6	7-20-93	1145	20.0	732	5.4	242	8.6	7.9	108
SSP-7	7-20-93	1415	20.0	730	4.2	243	8.4	8.1	100
SSP-8	7-20-93	1500	19.5	732	3.5	245	8.1	7.8	96
SSP-9	7-20-93	1530	17.5	730	4.0	249	8.4	7.6	100
SSP-10	7-21-93	1000	15.5	730	3.3	255	8.2	7.0	102
Trib-9	7-22-93	1150	23.0	732	.86	204	8.7	7.5	88
Trib-10	7-22-93	0900	20.5	733	1.2	296	7.2	7.6	110
Trib-11	7-21-93	1500	22.0	733	.31	245	6.9	7.2	90
Trib-12	7-21-93	1340	19.5	734	.27	286	8.2	7.3	108
Minimum			15.5		.27	204	6.9	7.0	88
Maximum			23.0		11	296	8.9	8.1	110
Median			19.5		3.8	243	8.3	7.6	96

Site ID	Nitrogen ammonia, dissolved (mg/L as N) (00608)	Nitrogen, nitrite dissolved (mg/L as N) (00613)	Nitrogen, ammonia + organic dissolved (mg/L as N) (00623)	Nitrogen, nitrite plus nitrate dissolved (mg/L as N) (00631)	Phosphorus, total (mg/L as P) (00665)	Phosphorus ortho, dissolved (mg/L as P) (00671)	Coliform fecal, 0.7 micron membrane filter (cols/100 mL) (31625)	Strepto-cocci fecal, KF agar (cols/100 mL) (31673)
SSP-1	0.02	<0.01	0.23	1.9	0.03	0.04	61	K110
SSP-2	.02	<.01	.23	2.0	.04	.03	110	150
SSP-3	.03	<.01	.30	1.8	.04	.03	K280	180
SSP-4	.03	<.01	.20	2.0	.04	.04	190	K70
SSP-5	.05	<.01	1.1	3.2	.04	.09	K270	680
SSP-6	.04	<.01	.26	2.3	.05	.04	90	88
SSP-7	.05	<.01	1.1	2.4	.04	.07	97	150
SSP-8	.04	<.01	.22	2.0	.03	.03	120	190
SSP-9	.03	<.01	.22	1.9	.04	.03	700	270
SSP-10	.04	<.01	<.20	1.8	.05	.03	1,200	420
Trib-9	.04	<.01	<.20	.75	.03	.04	120	170
Trib-10	.03	<.01	.5	2.2	.10	.15	1,400	>2,000
Trib-11	.03	<.01	<.20	3.2	.04	.06	120	440
Trib-12	.04	<.01	.33	4.2	.03	.03	120	520
Minimum	.02	<.01	<.20	.75	.03	.03	61	K70
Maximum	.05	<.01	1.1	4.2	.10	.15	1,400	>2,000
Median	.04	<.01	.23	2.0	.04	.04	120	185

Table 3.–*Water-quality data for selected surface-water site, wells, and springs located in the South Prong of Spavinaw Creek Basin*

[µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; five digit numbers in parentheses are STORET parameter codes used for computer storage of data; mg/L, milligrams per liter; <, less than; µg/L, micrograms per liter; --, no data; °C, degrees Celsius]

Site ID	Date of sample	Time of sample	Specific conductance (µS/cm at 25 °C) (00095)	pH, lab (00403)	Hardness, total (mg/L as CaO_3) (00900)	Noncarbonate, hardness (mg/L as $CaCO_3$) (00902)	Calcium, dissolved (mg/L as Ca) (00915)	Magnesium, dissolved (mg/L as Mg) (00925)	Sodium, dissolved (mg/L as Na) (00930)	Sodium, adsorption ratio (00931)
SSP-1	7-14-93	0845	235	7.7	98	4	37	1.4	3.9	0.2
W1	7-21-93	0900	186	7.4	110	5	40	2.3	5.7	.2
W4	7-22-93	1520	769	8.1	14	0	3.8	1.1	180	21
SPR-3	7-20-93	1000	240	7.6	110	13	39	1.9	5.0	.2
SPR-4	7-20-93	1105	224	7.2	98	22	36	2.0	5.0	.2

Site ID	Sodium percent (percent) (00932)	Potassium, dissolved (mg/L as K) (00935)	Chloride, dissolved (mg/L as Cl) (00940)	Sulfate, dissolved (mg/L as SO_4) (00945)	Fluoride, dissolved (mg/L as F) (00950)	Silica, dissolved (mg/L as SiO_2) (00955)	Arsenic, dissolved (µg/L as As) (01000)	Barium, dissolved (µg/L as Ba) (01005)	Beryllium, dissolved (µg/L as Be) (01010)	Boron, dissolved (µg/L as B) (01020)
SSP-1	8	1.9	5.4	3.2	<0.1	10	<1	45	<1	<20
W1	10	1.9	8.6	5.5	<.1	11	--	46	<1	<20
W4	96	2.7	7.2	.6	4.3	8.5	<1	7	<1	1,100
SPR-3	10	2.5	7.9	3.6	<.1	10	--	52	<1	<20
SPR-4	10	2.7	7.2	.6	4.3	8.5	<1	7	<1	1,100

Site ID	Cadmium, dissolved (µg/L as Cd) (01025)	Chromium, dissolved (µg/L as Cr) (01030)	Cobalt, dissolved (µg/L as Co) (01035)	Copper, dissolved (µg/L as Cu) (01040)	Iron, dissolved (µg/L as Fe) (01046)	Lead, dissolved (µg/L as Pb) (01049)	Manganese, dissolved (µg/L as Mn) (01056)	Molybdenum, dissolved (µg/L as Mo) (01060)	Nickel, dissolved (µg/L as Ni) (01065)
SSP-1	<1.0	<5	<3	<10	3	<10	2	<10	<10
W1	<1.0	<5	<3	<10	3	<10	<1	<10	10
W4	<1.0	<5	<3	<10	8	<10	<1	<10	<10
SPR-3	<1.0	<5	<3	<10	4	<10	4	<10	<10
SPR-4	<1.0	<5	<3	<10	8	<10	1	<10	<10

Site ID	Silver, dissolved (µg/L as Ag) (01075)	Strontium, dissolved (µg/L as Sr) (01080)	Vanadium, dissolved (µg/L as V) (01085)	Zinc, dissolved (µg/L as Zn) (01090)	Lithium, dissolved (µg/L as Li) (01130)	Residue, dissolved at 180 °C (mg/L) (70300)	Dissolved solids, sum (mg/L) (70301)	Specific conductance (µS/cm at 25 °C) (90095)	Alkalinity (mg/L as $CaCO_3$) (90410)
SSP-1	<1.0	38	<1	<4	4	136	128	234	97
W1	<1.0	52	<1	20	7	168	143	254	108
W4	<1.0	77	<1	<4	170	478	442	760	401
SPR-3	1.0	42	<1	11	5	176	138	240	96
SPR-4	<1.0	44	<1	10	5	166	130	221	82

DISSOLVED OXYGEN AND TEMPERATURE MONITORING

Hourly dissolved oxygen and temperature data were collected at two sites (SSP-2 and SSP-9) on the mainstem of the South Prong of Spavinaw Creek from July 22 to July 23 (figs. 3 and 4). These data were collected to determine the diel fluctuations in dissolved oxygen concentrations and temperature during changes in air temperature and sunlight intensity.

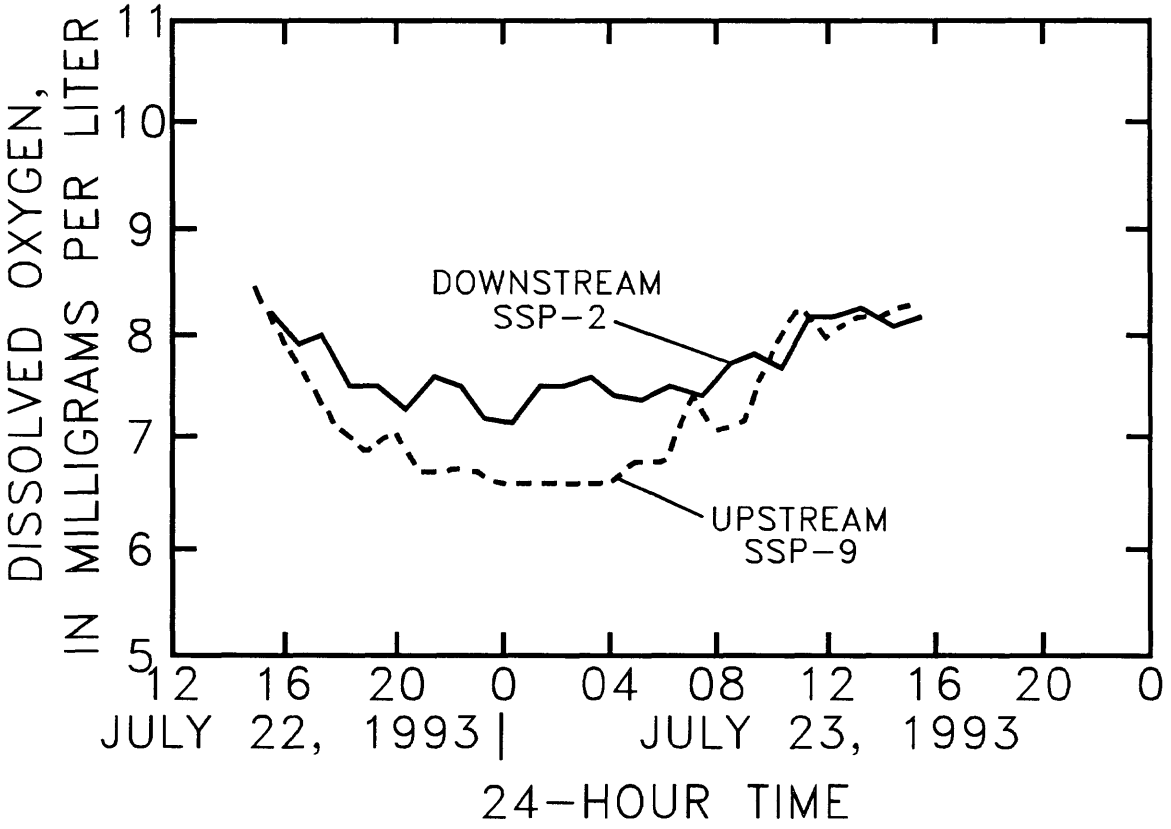

Figure 3.--Comparison of dissolved oxygen concentrations between sites SSP-2 and SSP-9, July 22-23, 1993.

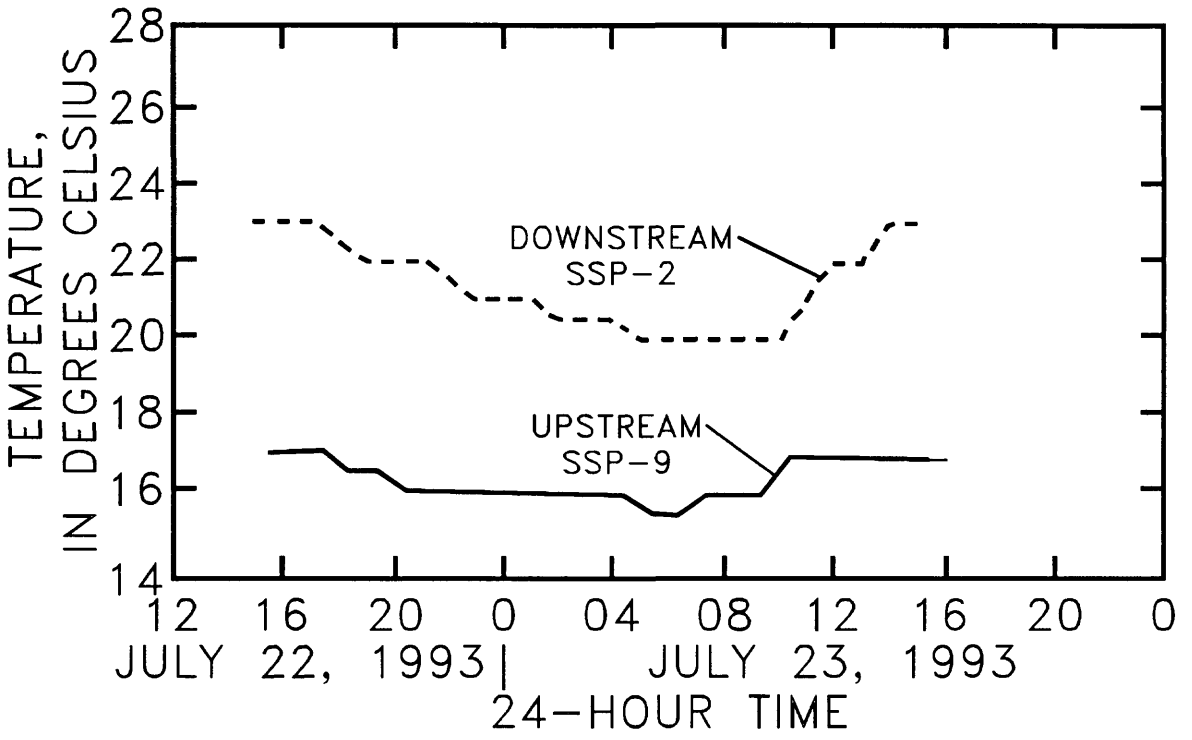

Figure 4.--Comparison of temperatures between sites SSP-2 and SSP-9, July 22-23, 1993.

At the downstream site (SSP-2), dissolved oxygen concentrations ranged from 6.6 to 8.4 mg/L with a median of 7.1 mg/L. The minimum dissolved oxygen concentration of 6.6 mg/L was recorded from 0005 to 0405 hours and the maximum dissolved oxygen concentration value of 8.4 mg/L was recorded at 1500 hours. The minimum stream temperature of 20.0 °C was recorded from 0505 to 1005 hours and the maximum stream temperature was 23.0 °C from 1405 to 1705 hours (fig. 4). The median stream temperature at site SSP-2 was 21.0 °C.

At the upstream site (SSP-9), dissolved oxygen concentrations ranged from 7.2 to 8.3 mg/L with a median of 7.6 mg/L. The minimum dissolved oxygen concentration of 7.2 mg/L was recorded from 2345 to 0045 hours and the maximum dissolved oxygen concentration of 8.3 mg/L was recorded at 1345 hours. The minimum stream temperature of 15.5 °C was recorded from 0545 to 0645 hours and the maximum stream temperature of 17.0 °C was recorded from 1545 to 1745 hours on July 22 and from 1045 to 1545 hours for July 23. The median stream temperature at site SSP-9 was 16.0 °C.

The stream temperature at the downstream site SSP-2 was about 4 to 5 °C warmer than the upstream site SSP-9, which is located close to two springs that account for all of the flow at site SSP-9. Site SSP-9 generally maintained a higher dissolved oxygen concentration than site SSP-2.

GROUND-WATER QUALITY

Water-quality samples were collected from four wells in the South Prong of Spavinaw Creek Basin (table 4). Two of these wells are relatively shallow wells (44 and 100 ft) penetrating the Springfield Plateau aquifer and one well was considerably deeper (1,000 ft) penetrating the Ozark aquifer. The depth of the fourth well was unknown. Specific conductance values ranged from 186 to 769 µS/cm (table 5). Dissolved ammonia was present in small concentrations in all four wells, ranging from less than 0.01 to 0.02 mg/L as nitrogen. Dissolved nitrite plus nitrate concentrations ranged from 0.04 to 3.5 mg/L as nitrogen. Fecal coliform bacteria counts for wells ranged from about 36 to 1,300 cols/100 mL with a median of 75 cols/100 mL. Fecal streptococci bacteria counts ranged from about 20 to 940 cols/100 mL with a median of 690 cols/100 mL. Analyses for common constituents and selected trace metals in wells (W1 and W4) (table 3) indicate that fluoride concentrations in well W4 exceeded the U.S. Environmental Protection Agency (USEPA) maximum contaminant level goal for drinking water (U.S. Environmental Protection Agency, 1994). Concentrations of sodium, boron and lithium also were greater in well W4, there are no drinking water standards established for these elements. Volatile organic compound analyses of samples from two wells (W1 and W4) indicate that toluene was present in both wells (table 6). Toluene concentrations were 0.3 micrograms per liter (µg/L) in well W1 and 0.2 µg/L in well W4. A concentration of 0.6 µg/L of chloroform was found to be present in well W4. No other volatile organic compounds were present above the reporting limits.

Water-quality data were collected from 10 springs in the basin and nitrite plus nitrate concentrations ranged from 0.43 to 3.9 mg/L as nitrogen (table 7). Dissolved ammonia plus organic nitrogen concentrations ranged from less than 0.20 to 0.64 mg/L as nitrogen. Orthophosphorus concentrations ranged from 0.02 to 0.09 mg/L as phosphorus. Fecal coliform bacteria counts ranged from less than 3 to greater than 2,000 cols/100 mL with a median of 370 cols/100 mL. Fecal streptococci bacteria counts ranged from less than 4 to greater than 2,000 cols/100 mL with a median of 435 cols/100 mL. Analyses for common constituents and selected trace metals at two springs (SPR-3 and SPR-4) indicate that most trace metals were not present above the reporting limit. Volatile organic compound analyses at two springs (SPR-3 and SPR-4) indicate that volatile organic compounds were not present above the reporting limit.

Table 4.--*Sampling site descriptions of wells and springs in the South Prong of Spavinaw Creek Basin*

Site number	Station name	Latitude	Longitude	Local site identifier
W1	Well 1	362117	0942316	19N32W04ADB
W2	Well 2	362021	0942140	19N32W11BDC
W3	Well 3	362018	0942318	19N32W09ADC
W4	Well 4	362338	0942603	20N32W19CBD
SPR-1	Spring 1	362323	0942546	20N32W19CCD
SPR-2	Spring 2	362250	0942522	20N32W30DAB
SPR-3	Spring 3	362214	0942415	20N32W32ADA
SPR-4	Spring 4	362202	0942402	20N32W33BCC
SPR-5	Spring 5	362144	0942320	20N32W33DDB
SPR-6	Spring 6	362122	0942313	19N32W04ADB
SPR-7	Spring 7	362020	0942124	19N32W11ACC
SPR-8	Spring 8	362117	0942317	19N32W04ADB
SPR-9	Spring 9	361913	0942406	19N32W16CBC
SPR-10	Spring 10	361923	0942239	19N32W15CAA

Table 5.--*Well depth and water-quality data for wells located in the South Prong of Spavinaw Creek Basin*

[Temperature reported to nearest 0.5 degree Celsius; °C, degrees Celsius; five digit numbers in parentheses are STORET parameter codes used for computer storage of data; --, no data; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; WH, whole water; FET, fixed endpoint titration; F, field; mg/L, milligrams per liter; <, less than; cols/100 mL, number of colonies per 100 milliliters of sample; K, non-ideal count]

Site ID	Date of sample	Time of sample	Water temperature (°C) (00010)	Depth of well, total (feet) (72008)	Elevation of land surface datum (feet above sea level) (72000)	Specific conductance (µS/cm at 25 °C) (00095)	pH, field (standard units) (00400)	Alkalinity, WH, FET, F (mg/L as $CaCO_3$) (00410)	Nitrogen ammonia, dissolved (mg/L as N) (00608)
W1	7-21-93	0900	21.0	100	1,175	186	7.2	104	0.02
W2	7-21-93	1445	22.0	44	1,255	249	7.2	110	.02
W3	7-22-93	1210	22.0	--	1,250	307	7.1	104	.01
W4	7-22-93	1520	20.5	1,000	1,080	769	8.6	388	<.01
Minimum			20.5	44	1,080	186	7.1	104	<0.01
Maximum			22.0	1,000	1,255	769	8.6	388	.02
Median			21.5	100	1,215	278	7.2	107	.15

Site ID	Nitrogen, nitrite dissolved (mg/L as N) (00613)	Nitrogen, ammonia + organic dissolved (mg/L as N) (00623)	Nitrogen, nitrite plus nitrate dissolved (mg/L as N) (00631)	Phosphorus, total (mg/L as P) (00665)	Phosphorus ortho, dissolved (mg/L as P) (00671)	Coliform fecal, 0.7 micron membrane filter (cols/100 mL) (31625)	Streptococci fecal, KF agar (cols/ 100 mL) (31673)	Well owner
W1	<0.01	0.26	1.3	0.04	0.07	K70	900	V. Briesacher
W2	<.01	<.20	3.5	.05	.06	K79	940	L. Webb
W3	<.01	<.20	2.0	.04	.01	1,300	480	B. Lundeen
W4	<.01	.21	.04	.03	<.01	K36	K20	O. Martinez
Minimum	<0.01	<0.20	0.04	0.03	<0.01	36	20	
Maximum	<.01	.26	3.5	.05	.07	1,300	940	
Median	<.01	<.20	1.7	.04	.04	75	690	

Table 6.--*Volatile organic compound data for selected wells and springs in the South Prong of Spavinaw Creek Basin*

[µg/L, micrograms per liter; five digit numbers in parentheses are STORET parameter codes used for computer storage of data; <, less than]

Site ID	Date of sample	Time of sample	Dichloro-difluoro-methane (µg/L) (34668)	Vinyl chloride (µg/L) (39175)	Trichloro-fluoro-methane (µg/L) (34488)	1,1-Dichloro-ethene (µg/L) (34501)	Methylene chloride (µg/L) (34423)
W1	7-21-93	0900	<0.2	<0.2	<0.2	<0.2	<0.2
W4	7-22-93	1520	<.2	<.2	<.2	<.2	<.2
SPR-3	7-20-93	1000	<.2	<.2	<.2	<.2	<.2
SPR-4	7-20-93	1105	<.2	<.2	<.2	<.2	<.2

Site ID	Trans-1,2-dichloro-ethane (µg/L) (34546)	1,1-Dichloro-ethane (µg/L) (34496)	Cis 1,2-Dichloro-ethene (µg/L) (77093)	Chloroform (µg/L) (32106)	1,1,1-Tri-chloro-ethane (µg/L) (34506)	Carbon tetra-chloride (µg/L) (32102)	Benzene (µg/L) (34030)	1,2-Di-chloro-ethane (µg/L) (32103)
W1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
W4	<.2	<.2	<.2	.6	<.2	<.2	<.2	<.2
SPR-3	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
SPR-4	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2

Site ID	Trichloro-ethene (µg/L) (39180)	1,2-Dichloro-propane (µg/L) (34541)	Bromodi-chloro-methane (µg/L) (32101)	Toluene (µg/L) (34010)	Tetra-chloro-ethene (µg/L) (34475)	Dibromo-chloro-methane (µg/L) (32105)	Chloro-benzene (µg/L) (34301)	Ethyl-benzene (µg/L) (34371)
W1	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	<0.2
W4	<.2	<.2	<.2	.2	<.2	<.2	<.2	<.2
SPR-3	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
SPR-4	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2

Site ID	Dimethyl-benzene (Xylenes-total) (µg/L) (81551)	Styrene (µg/L) (77128)	Bromo-form (µg/L) (32104)	1,3-Dichloro-benzene (meta) (µg/L) (34566)	1,4-Dichloro-benzene (para) (µg/L) (34571)	1,2-Dichloro-benzene (ortho) (µg/L) (34536)	Trichloro-trifluoro-ethane (1,1,2-Cl 1,2,2 F) (µg/L) (77652)
W1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.5
W4	<.2	<.2	<.2	<.2	<.2	<.2	<.5
SPR-3	<.2	<.2	<.2	<.2	<.2	<.2	<.5
SPR-4	<.2	<.2	<.2	<.2	<.2	<.2	<.5

Table 7.--*Discharge and water-quality data for springs located in the South Prong of Spavinaw Creek Basin*

[Temperature reported to nearest 0.5 degree Celsius; °C, degrees Celsius; five digit numbers in parentheses are STORET parameter codes used for computer storage of data; mm of Hg, millimeters of mercury; ft^3/s, cubic feet per second; µS/cm at 25 °C, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; WH, whole water; FET, fixed endpoint titration; F, field; <, less than; cols/100 mL, number of colonies per 100 milliliters of sample; K, non-ideal count; >, greater than; --, no data]

Site ID	Date of sample	Time of sample	Water temperature (°C) (00010)	Air pressure (mm of Hg) (00025)	Discharge, instantaneous (ft^3/s) (00061)	Specific conductance (µS/cm at 25 °C) (00095)	Oxygen, dissolved (mg/L) (00300)	pH, field (standard units) (00400)	Alkalinity, WH, FET, F (mg/L as $CaCO_3$) (00410)	Nitrogen ammonia, dissolved (mg/L as N) (00608)
SPR-1	7-14-93	1040	16.0	750	0.62	363	8.7	8.0	150	0.02
SPR-2	7-14-93	1220	14.0	750	.13	262	6.6	7.0	108	.03
SPR-3	7-20-93	1000	16.5	732	1.5	240	6.5	7.6	92	.04
SPR-4	7-20-93	1105	13.0	732	1.9	224	8.3	7.7	76	.04
SPR-5	7-20-93	1445	17.0	732	.52	213	7.3	7.7	84	.05
SPR-6	7-21-93	0950	15.0	730	.89	238	8.8	6.8	98	.03
SPR-7	7-21-93	1410	13.0	734	1.1	242	7.0	6.8	100	.03
SPR-8	7-21-93	1045	15.5	730	1.6	263	8.3	7.1	106	.04
SPR-9	7-22-93	1430	18.0	724	.05	162	7.8	6.7	60	.03
SPR-10	7-22-93	1015	21.5	733	1.1	273	6.5	7.2	98	.21
Minimum			13.0		.05	162	6.5	6.7	60	.02
Maximum			21.5		1.9	363	8.8	8.0	150	.21
Median			16.0		1.0	241	7.6	7.1	98	.04

Site ID	Nitrogen, nitrite dissolved (mg/L as N) (00613)	Nitrogen, ammonia + organic dissolved (mg/L as N) (00623)	Nitrogen, nitrite plus nitrate dissolved (mg/L as N) (00631)	Phosphorus, total (mg/L as P) (00665)	Phosphorus ortho, dissolved (mg/L as P) (00671)	Coliform fecal, 0.7 micron membrane filter (cols/ 100 mL) (31625)	Streptococci fecal, KF agar (cols/ 100 mL) (31673)	Name
SPR-1	<0.01	0.31	1.4	0.03	0.02	K510	K430	
SPR-2	<.01	<.20	1.5	.03	.03	<3	<4	
SPR-3	<.01	.23	2.8	.04	.04	K330	840	
SPR-4	<.01	.31	3.9	.07	.09	1,700	2,000	
SPR-5	<.01	.51	2.9	.06	.07	>2,000	1,600	
SPR-6	<.01	<.20	2.4	.03	.05	K21	440	V. Briesacher
SPR-7	<.01	<.20	2.2	.03	.04	K9	K10	
SPR-8	<.01	<.20	1.6	.04	.05	80	190	V. Briesacher
SPR-9	<.01	<.20	.43	.03	.03	K410	360	J. Elders
SPR-10	.06	.64	1.9	.12	.09	>2,000	>2,000	
Minimum	<.01	<.20	.43	.03	.02	<3	<4	
Maximum	.06	.64	3.9	.12	.09	>2,000	>2,000	
Median	<.01	<.20	2.1	.04	.05	370	435	

STREAMFLOW GAIN AND LOSS

Six losing streamflow reaches were identified during the study of the South Prong of Spavinaw Creek Basin. The mainstem of the South Prong of Spavinaw Creek was characterized by one losing reach. The instantaneous measured discharge at SSP-6 was 5.4 ft^3/s and the discharge at the downstream site (SSP-5) was 3.9 ft^3/s.

Five losing reaches were identified on tributaries in the South Prong of Spavinaw Creek Basin. A discharge of 1.2 ft^3/s was measured at Trib-10. Downstream from Trib-10, surface flow decreased and was redirected to subsurface flow and the streambed was dry for a distance of approximately six-tenths of a mile. Surface flow on the Grape Vine Hollow originated from SPR-9 where a discharge of 0.05 ft^3/s of flow was measured.

A significant increase in flow was observed at Trib-9 (at the State Highway 102 bridge) where 0.86 ft^3/s of flow was measured. Surface flow on Grape Vine Hollow disappeared entirely at a pool 150 yds downstream of the State Highway 102 bridge. Grape Vine Hollow remained dry for a distance of approximately 1.5 mi to SPR-8 where a discharge of 1.6 ft^3/s was measured.

Two tributaries and one spring were flowing in the upper reaches of Paw Paw Hollow. SPR-7 is inside a springhouse located on the north side of State Highway 102 and approximately one-tenth of a mile east of the mainstem of Paw Paw Hollow. A discharge of 1.1 ft^3/s was measured at the springhouse and all surface flow was redirected to subsurface flow prior to entering Paw Paw Hollow.

Surface flow was measured at two sites south of the State Highway 102 bridge, at Trib-12 where 0.27 ft^3/s of flow was measured and at Trib-11 where 0.31 ft^3/s of flow was measured. Surface flow from both tributaries joined at the south side of the State Highway 102 bridge and were redirected to subsurface flow on the north side of the State Highway 102 bridge. Paw Paw Hollow remained dry for a distance of approximately 2 mi from the State Highway 102 bridge to SPR-6 where a discharge of 0.89 ft^3/s was measured.

Measured streamflow ranged from 3.3 ft^3/s at SSP-10 to 10 ft^3/s at SSP-1. The largest increase in surface flow occurred between SSP-5 and SSP-4 where a 138 percent increase in surface flow was measured.

SUMMARY

A study of the South Prong of Spavinaw Creek Basin was undertaken between July 14 and July 23, 1993, to describe the water-quality conditions of the surface and ground water in the basin. Physical, nutrient, bacteriological, common constituent, selected metal and volatile organic compound data collected at various sites in the basin were used in the description. Streamflow measurements were conducted at various locations along the mainstem and at sites on major tributaries to identify streamflow gain and loss within the basin.

Water-quality data collected from 14 surface-water sites indicate that dissolved nitrite plus nitrate concentrations ranged from 0.75 to 4.2 mg/L as nitrogen. Four wells were sampled and dissolved nitrite plus nitrate concentrations ranged from 0.04 to 3.5 mg/L as nitrogen. Ten springs were sampled and dissolved nitrite plus nitrate concentrations ranged from 0.43 to 3.9 mg/L as nitrogen.

Bacteriological sampling conducted during this study indicates that fecal coliform bacteria counts for surface-water sites ranged from 61 to 1,400 cols/100 mL with a median of 120 cols/100 mL. Fecal streptococci bacteria counts for surface- water sites ranged from 70 to 2,000 cols/100 mL with a median of 185 cols/100 mL. Fecal coliform bacteria counts for springs ranged from less than 3 to greater than 2,000 cols/100 mL with a median of 370 cols/100 mL. Fecal streptococci bacteria counts for springs ranged from less than 4 to greater than 2,000 cols/100 mL with a median of 435 cols/100 mL.

Analyses for selected metals in ground- and surface-water samples indicate that most metals were not present in concentrations above reporting limits. Analyses for selected metals in two wells and two springs indicate that fluoride exceeded the USEPA's maximum contaminant level drinking water standard in one well.

Volatile organic compound data were collected in two wells and two springs. Toluene was present in both wells and chloroform was present in one well. Both were below the detection limit in the springs. All other volatile organic compounds were found to be below the detection limits in both wells and springs.

Diel dissolved oxygen concentrations and temperatures were measured at an upstream and downstream site on the mainstem of the stream. At the upstream site, dissolved oxygen concentrations ranged from 7.2 to 8.3 mg/L and temperatures ranged from 15.5 to 17.0 °C. Dissolved oxygen concentrations were higher and temperature values were lower at the upstream site, which is located close to two springs that produce all of the flow at that site.

Streamflow increased an average of 20 percent on the mainstem of the stream. One losing reach was discovered on the mainstem of the stream and five losing reaches on tributaries to the mainstem. There were four locations on tributaries where surface flow steadily decreased or was not present and the streambed became dry.

REFERENCES

Arkansas Agricultural Statistics Service, in press, Arkansas agricultural statistics: Arkansas Agricultural Experiment Station, Division of Agriculture, University of Arkansas Report Series, Fayetteville, Arkansas.

Britton, L.J., and Greeson, P.E., eds., 1987, Methods for collection and analysis of aquatic biological and microbiological samples: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A4, p. 37-50.

Buchanan, T.J., and Sommers, W.P., 1984, Discharge measurements at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A8, 65 p.

Fenneman, N.M., 1938, Physiography of eastern United States New York, McGraw-Hill Book Co., Inc., 714 p.

Freiwald, D.A., 1987, Streamflow gain and loss of selected streams in northern Arkansas: U.S.Geological Survey Water-Resources Investigations Report 86-4185.

Frezon, S.E., and Glick, E.E., 1959, Pre-Atoka rocks of Arkansas: U.S. Geological Survey Professional Paper 314-H, p. 171-189.

Lamonds, A.G., 1972, Water-resources reconnaissance of the Ozarks Plateaus Province, northern Arkansas, U.S. Geological Survey Hydrologic Investigations Atlas 383, 2 sheets.

Phillips, W.W. and Harper, M.D., 1977, Soil survey of Benton County, Arkansas: U.S. Soil Conservation Service, 85 p.

Sullavan, J.N., and Terry, J.E., 1970, Drainage areas of streams in Arkansas-Arkansas River Basin: U.S. Geological Survey Open-File Report, 75 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1992, Climatological data annual summary (by state): Asheville, North Carolina, National Climatic Data Center.

U.S. Environmental Protection Agency, 1994, Drinking water regulations and health advisories: EPA 822-R-94-001, 11 p.

Ward, J.R., and Harr, C.A., editors, 1990, Methods for collection and processing of surface-water and bed-material samples for physical and chemical analysis: U.S. Geological Survey Open-File Report 90-140, 71 p.

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