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GAIN-LOSS STUDY ALONG TWO STREAMS IN THE UPPER SABINE RIVER BASIN, TEXAS--AUGUST-SEPTEMBER 1981

By Dennis R. Myers

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METRIC CONVERSIONS

Factors for converting inch-pound units to metric equivalents are given in the following table:

Multiply	By	To obtain
inch	25.4	millimeter
foot	0.3048	meter
mile	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per mile [$(ft^3/s)/mi$]	0.01760	cubic meter per second per kilometer
foot per mile (ft/mi)	0.189	meter per kilometer

To convert degrees Celsius (°C) to degrees Fahrenheit (°F): °F = 9/5 X °C + 32.

GAIN-LOSS STUDY ALONG TWO STREAMS IN THE UPPER SABINE RIVER BASIN, TEXAS, AUGUST-SEPTEMBER 1981

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ABSTRACT

A gain-loss study was made August-September 1981 along the upper Sabine River from Lake Tawakoni to Farm Road 2517 near Carthage and along Lake Fork Creek from Lake Fork Reservoir to its junction (mouth) with the Sabine River. The hydrologic data collected during the gain-loss study indicated that during periods of low flow on the Sabine River, at least as much water as is released from Lake Tawakoni and from Lake Fork Reservoir will be available downstream at Farm Road 14 near Big Sandy and at Farm Road 2517 near Carthage. Gains from bank seepage and small tributary inflows compensate for losses due to evaporation, evapotranspiration, and loss of water into the alluvial aquifer.

Dissolved solids concentrations in the Sabine River, estimated from specific conductance, increased from about 120 milligrams per liter near the upstream end of the reach to about 400 milligrams per liter near the downstream end of the reach. Water with these concentrations of dissolved solids generally is suitable for most uses.

INTRODUCTION

The U.S. Geological Survey, in cooperation with the Sabine River Authority, conducted a low-flow delivery study during August and September 1981 along the Sabine River from Lake Tawakoni to Farm Road 2517 near Carthage, and along Lake Fork Creek from Lake Fork Reservoir to its junction (mouth) with the Sabine River (fig. 1). The purpose of the study was to determine how efficiently the Sabine and Lake Fork channels would transport low-flow releases from Lake Tawakoni and Lake Fork Reservoir to various downstream locations. Late summer was chosen for the study when rainfall is negligible, soil-moisture content generally is minimal, evapotranspiration rates are large, and, as indicated by streamflow records, discharge is at or near the yearly minimum.

HYDROLOGIC SETTING

The physical geography of the basin in the study area is characterized by relatively flat, sparsely populated land used for cultivated crops and pasture upstream from the Longview area, to rolling hills used for crops, pasture, and timber production downstream from the Longview area. The main economy in the basin consists of light industry, agriculture, beef and dairy cattle, wood products, and oil and gas production.

The river channels are characterized by flat slopes, meandering low-flow channels with a broad floodplain, a moderate to dense growth of trees and underbrush lining the banks of the low-flow channel, pools, and riffle reaches.

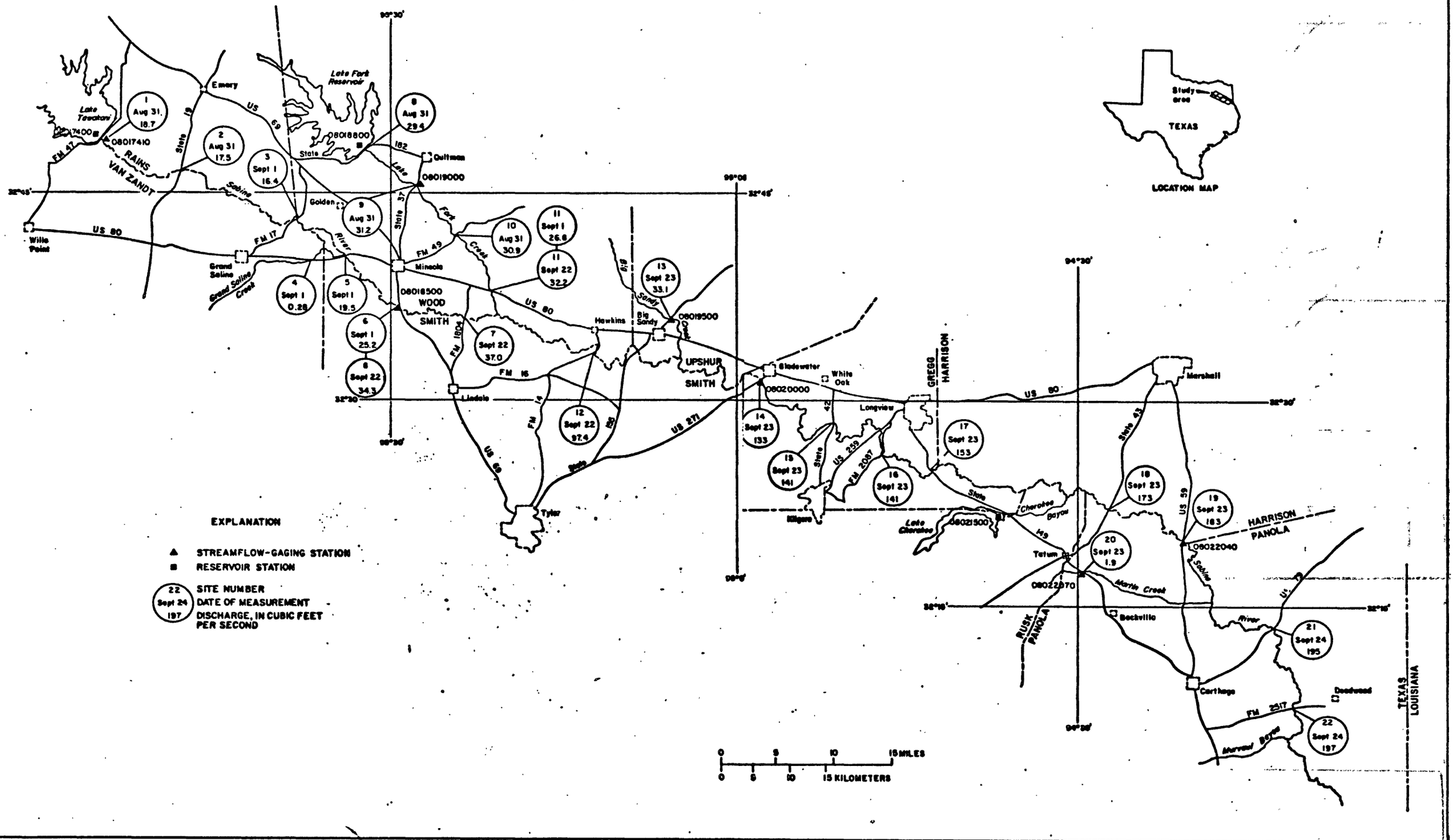

Figure 1.- Study area and location of measuring sites 2

In the 220-mile study reach, the river channel decreases in altitude about 212 feet, or an average slope of about 1 ft/mi. A review of streamflow records for gaging stations in the study area indicates that average monthly flow is highest from February through May and lowest during August and Sepetember. The mean annual rainfall ranges from about 40 inches in the west to about 48 inches in the east.

METHOD OF INVESTIGATION

Outflows from Lake Tawakoni and from Lake Fork Reservoir were adjusted on August 11, 1981 to a release rate of about 20 ft^3/s from each reservoir. This release rate approximates a reasonable release for a major downstream water user. Once set, the gate openings on the two reservoirs were held constant until the end of the study on September 24, 1981.

After the streamflow had stabilized throughout the reach, a series of discharge measurements (tables 1, 2, and 3) were begun on August 31 to determine gains and losses along the Sabine River from Lake Tawakoni to Farm Road 2517 near Carthage. During August 31 to September 1, six discharge measurements were made on the Sabine River and its tributaries from Lake Tawakoni to the gaging station Sabine River near Mineola (08018500) and four discharge measurements were made on Lake Fork Creek from Lake Fork Reservoir to near its junction with the Sabine River. Heavy rains on the evening of September 1 and during the early morning of September 2, produced local runoff. The gain-loss study was suspended until streamflow returned to about base-flow conditions.

By September 22, streamflow, including releases from the two reservoirs, had returned to almost base-flow conditions and the gain-loss study was resumed. Thirteen discharge measurements on the Sabine River and its tributaries were made during September 22-24 from the gaging station Sabine River near Mineola (08018500) downstream to Farm Road 2517 near Carthage. Diversions from the river and return flow to the river during the study were obtained from the major water users (cities of Longview, Gladewater, Kilgore, and Marshall, and Eastman Kodak Company at Longview) and are included in table 2. There was no outflow from Lake Cherokee during the study period.

The minor flow irregularities that occurred during the study period, and the long travel time that is common to this reach of the Sabine River created unfavorable conditions for a conventional gain-loss study using a series of discharge measurements. During the part of the study when flow was affected by rainfall, records from streamflow-gaging stations were used and a less detailed gain-loss determination was made. The base-flow period for August 28-30, 1981 was selected for this analysis because of the rather stable flow conditions that existed at the time.

DISCUSSION OF RESULTS

Because flood runoff affected different reaches of this gain-loss study, the study area has been divided into three reaches: (a) Sabine River from Lake Tawakoni to near Mineola (sites 1-6); (b) Lake Fork Creek from Lake Fork

Table 1.--Index to location and discription of gain-loss study measuring sites
[mi^2 = square miles; lat = latitude; long = longitude; ft = feet; mi = mile]

Site	Station number and name	Stream	Tributary to	Location	Drainage area (mi^2)
1	08017410 Sabine River near Wills Point, Tex.	Sabine River	Gulf of Mexico	Lat 32°48'34", long 95°54'46", on right bank Wills Point, at downstream side of Farm Road 47 bridge, 9.0 mi northeast of Wills Point, and at river mi 514.3.	756
2	08017500 Sabine River near Emory, Tex. (discontinued)	Sabine River	Gulf of Mexico	Lat 32°46'23", long 95°47'56", at State Highway 19 bridge, 13.8 mi downstream from Lake Tawakoni, and at river mi 500.7.	888
3	08018000 Sabine River near Golden, Tex. (discontinued)	Sabine River	Gulf of Mexico	Lat 32°43'13", long 95°38'06", 1,000 ft upstream from Farm Road 17 bridge, 4.3 mi southwest of Golden, and at river mi 481.0.	1,123
4	08018200 Grand Saline Creek near Grand Saline, Tex. (discontinued)	Grand Saline Creek	Sabine River	Lat 32°40'20", long 95°36'35", at U.S. Highway 80 bridge, 1.7 mi upstream from mouth, and 5.5 mi east of Grand Saline.	91.4
5	08018300 Sabine River at U.S. Highway 80 near Mineola, Tex. (discontinued)	Sabine River	Gulf of Mexico	Lat 32°40'23", long 95'34'98", at U.S. Highway 80, 3.4 mi west of Mineola, and at river mi 471.9.	1,147

Table 1.--Index to location and discription of gain-loss study measuring sites--Continued
[mi^2 = square miles; lat = latitude; long = longitude; ft = feet; mi = mile]

Site	Station number and name	Stream	Tributary to	Location	Drainage area (mi^2)
6	08018500 Sabine River near Mineola, Tex.	Sabine River	Gulf of Mexico	Lat 32°46'49", long 95°29'08", at U.S. Highway 69 bridge, 3.5 mi south of Mineola, 16.2 mi upstream from Lake Fork Creek, and at river mi 461.1.	1,357
7	08018600 Sabine River near Lindale, Tex. (discontinued)	Sabine River	Gulf of Mexico	Lat 32°36'05", long 95°23'28", at Farm Road 1804 bridge, 4.2 mi upstream from Lake Fork Creek, 6.0 mi northeast of Lindale, and at river mi 448.8.	--
8	--	Lake Fork Creek	Sabine Creek	Lat 32°48'17", long 95°31'31", 1,200 ft downstream Creek from State Highway 182 bridge, 4.4 mi west-northwest of Quitman, and 30.8 river mi upstream from mouth.	--
9	08019000 Lake Fork Creek near Quitman, Tex.	Lake Fork Creek	Sabine River	Lat 32°45'47", long 95°27'46", at State Highway 37 bridge, 2.4 mi south of Quitman, and 23.4 river mi upstream from mouth.	585
10	--	Lake Fork Creek	Sabine River	Lat 32°42'07", long 95°24'27", at Farm Road 49 bridge, 5.4 mi northeast of Mineola, and 13.8 river mi upstream from mouth.	--
11	--	Lake Fork Creek	Sabine River	Lat 32°37'57", long 95°21'12", at U.S. Highway 80 bridge, 8.0 mi east of Mineola, and 3.6 river mi upstream from mouth.	--

Table 1.--Index to location and discription of gain-loss study measuring sites--Continued
[mi^2 = square miles; lat = latitude; long = longitude; ft = feet; mi = mile]

Site	Station number and name	Stream	Tributary to	Location	Drainage area (mi^2)
12	--	Sabine River	Gulf of Mexico	Lat 32°33'35", long 95°12'23", 1,000 ft downstream from Farm Road 14 bridge, 1.9 mi south of Hawkins, and at river mi 427.4.	--
13	08019500 Big Sandy Creek near Big Sandy, Tex.	Big Sandy Creek	Sabine River	Lat 32°36'12", long 95°05'32", at State Highway 155 bridge, 1.6 mi northeast of Big Sandy, and 6.5 river mi upstream from mouth.	231
14	08020000 Sabine River near Gladewater, Tex.	Sabine River	Gulf of Mexico	Lat 32°31'37", long 94°57'36", at U.S. Highway 271 bridge, 1.2 mi southwest of Gladewater, and at river mi 397.5.	2,791
15	--	Sabine River	Gulf of Mexico	Lat 32°28'34", long 94°50'58", 500 ft upstream from State Highway 42 bridge and 3.0 mi south of White Oak, and at river mi 382.9	--
16	--	Sabine River	Gulf of Mexico	Lat 32°26'16", long 94°46'50", 400 ft downstream from Farm Road 2087 bridge, 5.0 mi southwest of Longview, and at river mi 370.1.	--
17	--	Sabine River	Gulf of Mexico	Lat 23°25'00", long 94°42'34", at State Highway 149 bridge, 6.6 mi southeast of Longview, and at river mi 362.2	--

Table 1.--Index to location and discription of gain-loss study measuring sites--Continued
[mi^2 = square miles; lat = latitude; long = longitude; ft = feet; mi = mile]

Site	Station number and name	Stream	Tributary to	Location	Drainage area (mi^2)
18	08022000 Sabine River near Tatum, Tex. (discontinued)	Sabine River	Gulf of Mexico	Lat 32°22'11", long 94°27'28", at State Highway 43 bridge, 5.1 mi northeast of Tatum, and at river mi 339.4	3,493
19	08022040 Sabine River near Beckville, Tex.	Sabine River	Gulf of Mexico	Lat 32°19'38", long 94°21'12", at U.S. Highway 59 bridge, 8.4 mi northeast of Beckville, and at river mile 327.0.	3,589
20	08022070 Martin Creek near Tatum, Tex.	Martin Creek	Sabine River	Lat 32°17'44", long 94°29'29", at State Highway 149 bridge, 2.0 mi southeast of Tatum, and 15.0 river mi upstream from mouth.	148
21	--	Sabine River	Gulf of Mexico	Lat 32°13'28", long 94°13'33", at U.S. Highway 79 bridge, 8.0 mi northeast of Carthage, and at river mi 308.0.	--
22	--	Sabine River	Gulf of Mexico	Lat 32°07'31", long 94°12'06", at Farm Road 2517 bridge, 3.7 mi west of Deadwood, and at river mi 296.2.	--

Table 2.--Tabulation of hydrologic data and changes in flow, Sabine River gain-loss study
[ft^3/s = cubic feet per second; °C = degrees Celsius;
micromhos = micromhos per centimeter at 25° Celsius]

Site	a/River mile	August 31-September 24, 1981 study period: Measured discharge (ft^3/s) Main stream	Tributary	Diversion	Gain-loss	August 28-30, 1981 base-flow period: Discharge (ft^3/s) Main stream	Tributary	Gain-loss	Temperature (°C)	Specific conductance (micromhos)
1	514.3	18.7	-	-	-	c/ 18	-	-	29.0	200
2	500.7	17.5	-	-	-1.2	-	-	-	28.0	204
3	481.0	16.4	-	-	-1.1	-	-	-	27.0	237
4	-	-	0.28	-		-	-	-	26.5	1,540
5	471.9	19.5	-	-	+2.8	-	-	-	25.5	269
6	461.1	*25.2	-	-	+5.7	c/ 21	-	+3	-	-
6	461.1	34.3	-	-	-	-	-	-	21.5	342
7	448.8	37.0	-	-	+2.7	-	-	-	23.5	364
11	-	-	32.2	-	-	-	c/26	-	21.5	264
12	427.4	97.4	-	-	+28.2	-	-	-	23.0	350
13	-	-	33.1	-		-	c/13	-	21.0	91
14	397.5	133	-	-	+2.5	c/105	-	+45	21.5	378
-	396.5	-	b/1.0	-	-	-	-	-	-	-
15	382.9	141	-	-	+7.0	-	-	-	24.5	420
-	375.2	-	-	b/11.5	-	-	-	-	-	-
-	370.2	-	b/5.4	-	-	-	-	-	-	-
16	370.1	141	-	-	+6.1	-	-	-	-	131
-	368.2	-	b/12.5	-	-	-	-	-	-	-
17	362.2	153	-	-	-0.5	-	-	-	24.0	400
-	361.1	-	-	b/ 6.3	-	-	-	-	-	-
-	360.2	-	b/ 6.5	-	-	-	-	-	-	-
-	334.0	-	b/ 5.4	-	-	-	-	-	-	-
18	339.4	173	-	-	+14.4	-	-	-	25.5	450
19	327.0	183	-	-	+10.0	c/180	d/13	+62	26.5	670
20	-	-	c/ 1.9	-	-	-	-	-	-	-
21	308.0	195	-	-	+10.1	-	-	-	26.0	560
22	296.2	197	-	-	+2.0	-	-	-	27.5	443

* Measurement taken prior to rise in stage.
a/ Upstream from mouth; from U.S. Army Corps of Engineers, Fort Worth, Texas.
b/ Reported by local users.
c/ From digital-recorder record.
d/ Average of diversions and effluents reported by local users.

Table 3.--Tabulation of hydrologic data and changes in flow, Lake Fork Creek gain-loss study
[ft^3/s = cubic feet per second; °C = degrees Celsius; micromhos = micromhos per centimeter at 25° Celsius]

Site	Date	a/River mile	Measured discharge (ft^3/s)				Temperature (°C)	Specific conductance (micromhos)
			Main stream	Tributary	Diversion	Gain-loss		
	1981							
8	Aug. 31	a/30.8	29.4	-	-	-	-	214
9	31	23.4	31.2	-	-	+1.8	-	214
10	31	13.8	30.9	-	-	-0.3	27.0	220
11	Sept. 1	3.6	26.8	-	-	-4.1	-	222

a/ Upstream from mouth; from U.S. Army Corps of Engineers, Fort Worth, Texas.

Reservoir to the mouth (sites 8-11); and (c) Sabine River from near Mineola to Farm Road 2517 near Carthage (sites 6, 7, 11-22). These reaches are discussed separately.

Sabine River from Lake Tawakoni to near Mineola

Discharge measurements (sites 1-6) made August 31 to September 1, 1981, indicate only a slight loss (2.3 ft^3/s) in flow in the first 33.3 river miles and then an increase in flow of 8.5 ft^3/s in the next 19.9 river miles. The overall gain in this 53.2-mile reach of the river was 6.2 ft^3/s, or about 0.1 $(ft^3/s)/mi$. The gain may actually be less because the hydrograph at the Mineoloa gage indicates that the September measurement at that site was made on a slightly rising river stage. Using the August 28-30 discharge record for the streamflow gaging stations at the end of this subreach, the base flow increased from 18 to 21 ft^3/s, a gain of about 3 ft^3/s. This gain is about one-half of the increase that was determined by the direct discharge measurements.

Lake Fork Creek from Lake Fork Reservoir to near Mouth near Mineola

Discharge measurements along Lake Fork Creek (sites 8-11) during August 31 to September 1 indicate that there was only a slight decrease in flow (2.6 ft^3/s) from State Highway 182 just downstream from Lake Fork Reservoir to U.S. Highway 80 east of Mineola.

Sabine River from near Mineola to Farm Road 2517 near Carthage

During August 28-30 when flow in the river was relatively stable, discharge records for the gaging stations Sabine River near Mineola (site 6), Lake Fork Creek near Mineola (site 9), Big Sandy Creek at Big Sandy (site 13), Sabine River at Gladewater (site 14), and Sabine River near Beckville (site 19) were used to compute the gains and losses in the river. The assumption was made that the return flows and diversions for the cities and for Eastman Kodak, as reported for September 23, were almost constant and would apply to the base period of August 28-30. Following the heavy rainfall of September 1-2, the river system was allowed to stabilize to low-flow conditions with continued constant releases from Lake Tawakoni and Lake Fork Reservoirs. The study was resumed and discharge measurements were made September 22-24 along the Sabine River and its tributaries from near Mineola to near Carthage (sites 6, 7, and 11-22).

The gain in flow of the Sabine River from Mineola (site 6) to Gladewater (site 14) was about 45 ft^3/s during August 28-30, whereas the gain based on discharge measurements for September 22-23 was 33.4 ft^3/s. The gain in flow of the Sabine River near Gladewater (site 14) to the Sabine River near Beckville (site 19) was about 62 ft^3/s during August 28-30, whereas the gain based on discharge measurements for September 22-23 and reported diversions and return flows was 37 ft^3/s. However, during early September, streamflow between Mineola and Gladewater was changing (rising) because of rainfall in the area. Although flow upstream at Sabine River near Wills Point (site 1)

was fairly stable, a small rise was moving downstream and the discharge measurement of September 22 at Mineola (site 6) probably contained some flood runoff as did the discharge measurement of September 23 at Gladewater (site 14). The increase in flow for the base period August 28-30 between Sabine River near Mineola (site 6) and Sabine River near Gladewater (site 14) was 0.71 $(ft^3/s)/mi$; and between Sabine River near Gladewater (site 14) and Sabine River near Beckville (site 19) is was 0.89 $(ft^3/s)/mi$. The lower reach of the Sabine River from Beckville (site 19) to Farm Road 2517 (site 22) indicates a gain of about 0.4 $(ft^3/s)/mi$ during September 23-24.

During this investigation, losses to evaporation, evapotranspiration, and seepage into the aluvium were probably as great as could be expected at any time during the year. The discharge measurements and the diversions and return flows reported by the cities of Longview, Gladewater, Kilgore, and Marshall and from Eastman Kodak indicate that the river was gaining flow throughout most of the study reach.

WATER QUALITY

The temperature and specific conductance recorded during the study for each discharge measurement are listed in tables 2 and 3. As a general rule, in a river system, the dissolved-solids concentration is about 60 percent of the specific conductance. A gradual increase in specific conductance from about 200 micromhos (dissolved solids concentrations about 120 milligrams per liter) just downstream from the reservoirs to a maximum of 670 micromhos (dissolved-solids concentration about 400 milligrams per liter) near the downstream end of the reach indicates that the water quality is suitable for most uses. The specific conductance of Grand Saline Creek was 1,540 micromhos but the discharge was so small that the effect on the quality of water in the Sabine River was negligible.

SUMMARY AND CONCLUSIONS

The analysis of the hydrologic data collected during this study was complicated by the effects of rainfall that fell over the Sabine River basin on September 1-2. However, the data indicate that during periods of low flow on the Sabine River, at least as much water as is released from Lake Tawakoni and from Lake Fork Reservoir will be available downstream at Farm Road 14 near Big Sandy and at Farm Road 2517 near Carthage. Bank seepage and small tributary inflow will compensate for most losses due to evaporation, evapotranspiration, and loss of water into alluvial aquifers.

Dissolved-solids concentrations in the Sabine River, estimated from specific conductance, increased from about 120 milligrams per liter near the upstream end of the reach to about 400 milligrams per liter near the downstream end of the reach. Water with these concentrations of dissolved solids generally is suitable for most uses.