TEXAS WATER DEVELOPMENT BOARD

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# BASE-FLOW STUDIES
# LEON AND LAMPASAS RIVERS, TEXAS
# QUANTITY AND QUALITY, JANUARY 16-17, 1968

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## INTRODUCTION

This base-flow study of the lower reaches of the Leon and Lampasas Rivers, Texas, was made by the U.S. Geological Survey in cooperation with the Texas Water Development Board. Originally, the study was to include the Little River (formed by the confluence of the Leon and Lampasas Rivers) and its principal tributary, the San Gabriel River. However, heavy rains that occurred after the study was begun precluded the investigation of the Little and San Gabriel Rivers.

The purposes of the investigation of the Leon and Lampasas Rivers were (1) to determine the quantity of tributary inflow and the amount of interchange of surface and ground water in the main streams, (2) to relate the nature and concentrations of dissolved constituents in the base flow to geology and to the activities of man, and (3) to evaluate the water for minicipal supply, irrigation, and industrial use.

During the study, conditions were favorable for determining gains and losses of streamflow; evapotranspiration was negligible, and most of the flow was sustained by ground water effluent. Moreover, only one active diversion was located throughout the reaches studied.

## DESCRIPTION OF THE DRAINAGE AREA

The Leon and Lampasas Rivers join about 7 miles southeast of Belton in central Bell County to form the Little River. The 16.7-mile reach of the Leon River included in this study extends from the Little River to Belton Dam; the 15.8-mile reach of the Lampasas River extends from Little River to the construction site of Stillhouse Hollow Dam (Fig. 2).

West of Belton, the drainage areas of both the Leon and Lampasas Rivers are rolling to hilly upland prairies with deeply incised stream valleys. The native vegetation is mainly grass, but in many places shallow soils on the rocky slopes support a dense growth of small oak, juniper, and mesquite. East of Belton, the drainage area is a gently rolling prairie less than 750 feet in elevation. The native vegetation is mainly grass, but in places scattered mesquite, cacti, and other shrubs form a thick cover. Elm, hackberry, pecan, and other hardwoods occur along many of the streams.

Throughout much of the drainage area, the beds of both the Leon and Lampasas Rivers are composed of alluvium. Long pools formed by gravel bars are common in both streams.

## GENERAL GEOLOGY

The geology of Bell County, including the area studied during this investigation, has been described in Adkins and Arick (1930). Rocks exposed in the study area range in age from Cretaceous to Quaternary (Fig. 2).

The western part of the drainage area is underlain largely by formations of the Fredericksburg Group of Cretaceous age—including the Walnut Clay, Comanche Peak Limestone, and Edwards Limestone. The Walnut Clay, which consists of blue or blackish clay and marl with subordinate amounts of impure limestone, crops out in the drainage area of Nolan Creek and along the upper reach of the Lampasas River. The Comanche Peak, which consists mostly of chalky limestone, crops out almost exclusively in steep scarps beneath the more resistant caprock of Edwards Limestone. Neither the Walnut Clay nor the Comanche Peak are capable of absorbing or storing significant quantities of water. The Edwards Limestone crops out as an irregular strip in the west-central part of Bell County. North of the Lampasas River, the Edwards occurs as the hard cap of interstream divides and outliers; south of the river, it forms a strip of rocky upland. At the surface, the Edwards is a well-bedded, hard limestone.

Rocks of the Washita Group of Cretaceous age crop out in small areas near the eastern limit of the drainage area. This group, composed of limestone, marl, and calcareous clay, includes the Georgetown Limestone, Grayson Marl, and Buda Limestone.

Other rocks that crop out near the eastern limit of the study area are the Eagle Ford Shale and Austin Chalk of Cretaceous age. These rocks consist of shale, limestone, chalky limestone, and marl.

Throughout much of the area investigated, the beds and banks of both the Leon and Lampasas Rivers consist of Quaternary alluvium, which is composed of varying amounts of clay, silt, sand, and gravel.

## ANALYSIS OF DATA

Discharge was measured and water samples were collected for chemical analysis at 20 sites in the study area (Fig. 2). The results of discharge measurements are given in Table 1; results of chemical analyses are given in Table 2. These data are summarized graphically in Figures 1 and 2. In Figure 2, each chemical analysis is represented by a diagram. The shape of each diagram indicates the relative concentration of the principal chemical constituents; the size indicates roughly the degree of mineralization. Figure 1 shows the downstream variations in streamflow and dissolved-mineral content. River mileages on the main-stem Leon and Lampasas Rivers (Table 1, Fig. 2, and the following discussion) are measured upstream from their confluence, which is designated as mile 0.0.

### Leon River—Mile 16.7 to Mile 12.3

Because repairs were being made to Belton Dam, no water was being released to the Leon River from Belton Reservoir. To facilitate repairs to the dam, however, 4.46 cfs (cubic feet per second) was pumped from the stilling basin below the dam. This flow entered the Leon River through a man-made channel at mile 16.7 (site 1). Water at this site contained 253 mg/l (milligrams per liter) dissolved solids and was of calcium bicarbonate type (Fig. 2). Although the bed and banks of the main stem Leon River between miles 16.7 and 12.3 consist mostly of alluvium, much of the drainage area in this reach is underlain by the Edwards and Georgetown Limestones. Flow in this 4.4-mile reach increased from 4.46 cfs at mile 16.7 (site 1) to 9.19 cfs at mile 12.3 (site 6), an apparent gain of 4.73 cfs. However, at mile 13.2, the city of Temple was diverting about 6.1 cfs for mumicipal use (L. W. Smith, oral communication). Thus, had diversion not occurred, the gain in streamflow would have totaled 10.8 cfs. Measured tributary inflow totaled 1.37 cfs, or about 13 percent of the gain in flow of the main stem, while ground-water inflow was about 9.4 cfs, or about 87 percent of the gain.

The concentration of dissolved solids in mainstream water increased from 253 mg/l at mile 16.7 (site 1) to 306 mg/l at mile 12.3 (site 6). Principal dissolved constituents at both sites were calcium and bicarbonate. The dissolved-solids content of tributary inflow ranged from 178 mg/l (site 4) to 317 mg/l (site 5). Although bicarbonate was the principal anion in water from tributaries, the principal cations varied. The principal cations were calcium and magnesium at site 3; calcium at site 4; and sodium, magnesium, and calcium at site 5. Calculations based on these data indicate that groundwater contributions to the main stem contained about 350 mg/l dissolved solids, much of which was calcium and bicarbonate.

### Leon River—Mile 12.3 to Mile 7.7

Between miles 12.3 and 7.7, the main stem Leon River is underlain largely by the Georgetown Limestone, whereas the principal tributaries are underlain by several different formations. Rocks that crop out in the drainage area of Pepper Creek include the Georgetown Limestone and Grayson Marl. Bird Creek traverses outcrops of the Grayson Marl, Eagle Ford Shale, Austin Chalk, and alluvium. The drainage area of Nolan Creek, the largest of the tributaries, is underlain largely by Edwards Limestone.

Flow in the main stem Leon River increased from 9.19 cfs at mile 12.3 (site 6) to 52.3 cfs at mile 7.7 (site 11), an apparent gain of 43.1 cfs. Tributary inflow totaled 44.2 cfs. Thus, no significant gains or losses of flow occurred in the channel of the main stem.

Inflow from Nolan Creek was 24.7 cfs, or about 56 percent of the total inflow from tributaries.

The dissolved-solids content of water in the main stem increased from 306 mg/l at site 6 to 428 mg/l at site 11. Water at both sites was the calcium bicarbonate type. The dissolved-solids content of inflow from tributaries ranged from 237 mg/l (site 7) to 460 mg/l (site 9) and averaged about 430 mg/l. Water in the principal tributaries was of calcium bicarbonate type.

### Leon River—Mile 7.7 to Mile 0.0

The lower 7.7—mile reach of the Leon River is underlain by alluvium and Austin Chalk.

Tributary inflow in this reach totaled 5.32 cfs. Although discharge in the lower reach of the Leon River was not measured, measurements of the Lampasas River (site 19) and the Little River (site 20) indicate that flow at the mouth of Leon River was about 58 cfs. Similarly, the sum of flow at mile 7.7 (site 11) on the Leon River and inflow from tributaries (sites 12 and 13) totaled about 58 cfs. These data indicate no significant channel losses or gains of mainstream flow.

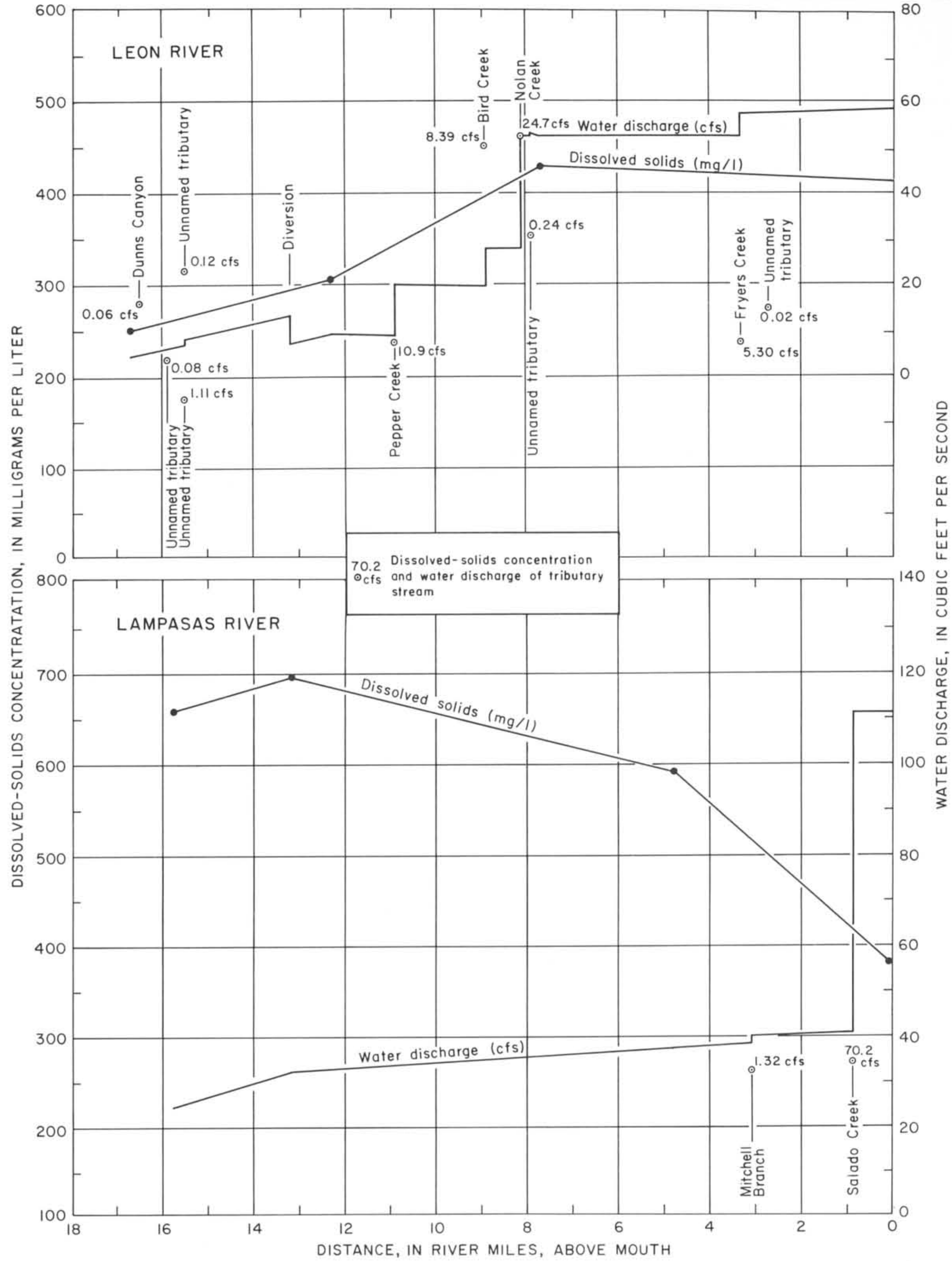


Figure 1

Dissolved-Solids Concentration and Water Discharge, January 16-17, 1968

Water in Fryers Creek (site 12), the principal tributary, contained 235 mg/l dissolved solids and was of calcium bicarbonate type.

### Lampasas River—Mile 15.8 to Mile 13.2

The uppermost site investigated on the Lampasas River was at mile 15.8 (site 14), which is about 1,500 feet below the site of Stillhouse Hollow Dam. Although this dam was under construction during the study, no water was being impounded. In an earlier study of the Lampasas River, Mills and Rawson (1965) showed that the principal contributor of base flow and dissolved minerals to the Lampasas River above the site of Stillhouse Hollow Dam is Sulphur Creek. According to Mills and Rawson (1965, p. 5), the base flow of Sulphur Creek contains more than 1,100 mg/l dissolved solids and is of sodium chloride type. During the present study, inflow from the upper reaches of the Lampasas River at mile 15.8 (site 14) contained 660 mg/l dissolved solids. Principal dissolved constituents were sodium and chloride.

Between miles 15.8 (site 14) and 13.2 (site 15), the channel of the Lampasas River is floored with alluvium and is bordered by outcrops of the Edwards Limestone. Streamflow in this reach increased from 24.6 cfs at site 14 to 32.8 cfs at site 15, an apparent gain of 8.2 cfs. The dissolved-solids content of the water increased from 660 mg/l at mile 15.8 (site 14) to 698 mg/l at mile 13.2 (site 15). Water at both sites was similar in chemical composition; principal dissolved constituents were sodium and chloride. These data indicate that much of the apparent gain in flow at site 15 probably resulted from underflow in the alluvium returning to the surface.

### Lampasas River—Mile 13.2 to Mile 4.8

The channel of the Lampasas River throughout much of this 8.4-mile reach is floored with alluvium and is bordered by Georgetown Limestone. Although no inflow from tributaries was noted, streamflow increased from 32.8 cfs at mile 13.2 (site 15) to 38.0 cfs at mile 4.8 (site 16). The dissolved-solids content decreased from 698 mg/l at mile 13.2 (site 15) to 595 mg/l at mile 4.8 (site 16). Water at both sites was of sodium chloride type, but the percentage of sodium chloride decreased at the downstream site. The 5.2 cfs increase in flow was insufficient to account for the 103 mg/l decrease in dissolved solids. Apparently, a minor interchange of surface and ground water occurred in this reach.

### Lampasas River—Mile 4.8 to Mile 0.0

The final 4.8 miles of the Lampasas River is underlain by alluvium and Austin Chalk. Flow in this reach of the main stem increased from 38.0 cfs at mile 4.8 (site 16) to 112 cfs at mile 0.1 (site 19). Dissolved solids decreased from 595 mg/l at mile 4.8 to 385 mg/l at mile 0.1, and the water was altered in chemical composition. At mile 4.8, principal dissolved constituents in the water were sodium and chloride; at mile 0.1, principal constituents were calcium and bicarbonate. Much of the decrease in mineralization and change in chemical composition resulted from the inflow of water from Salado Creek (site 18). Salado Creek contributed 70.2 cfs or about 95 percent of the gain in mainstream flow. Water contributed by Salado Creek contained 275 mg/l dissolved solids and was of calcium bicarbonate type.

The lower reach of Salado Creek is underlain mostly by Austin Chalk and Georgetown Limestone. However, much of the base flow of Salado Creek probably originates in the upper reaches of the drainage area, which is underlain by Edwards Limestone.

### Little River—Mile 102

At site 20, about one-fourth mile below the confluence of the Leon and Lampasas Rivers, the flow of Little River was 170 cfs. The water contained 422 mg/l dissolved solids and was of calcium bicarbonate type. About 58 cfs (34 percent) of the flow was contributed by the Leon River; 112 cfs (66 percent) was contributed by the Lampasas River.

## RELATION OF QUALITY OF WATER TO USE

Surface water from the Leon, Lampasas, and Little Rivers is being used or developments are being planned for municipal, industrial, and irrigation uses.

The standards published by the U.S. Public Health Service (1962) generally are accepted as the basis for determining the suitability of a water for municipal use. According to these standards, the suggested limits for dissolved solids, chloride, and sulfate are 500 mg/l, 250 mg/l, and 250 mg/l, respectively. Waters in streams throughout much of the area studied meet the U.S. Public Health Service suggested limits for dissolved solids, chloride, and sulfate. Water in the upper 11.0-mile reach of the Lampasas River contained more than 500 mg/l dissolved solids; moreover, water in the upper 2.6-mile reach contained more than 250 mg/l chloride. However, waters containing more than 500 mg/l dissolved solids and 250 mg/l chloride have been used as municipal supplies in many parts of the United States without adverse effects.

Hardness is another property usually considered in evaluating a water for municipal supply. Soaps and synthetic detergents react with calcium, magnesium, and other hardness components to form an insoluble curd; thus, the effective concentration of soaps and detergents is decreased in hard water. The base flow in streams throughout the reaches studied is hard or very hard and probably will require softening for municipal use.

The water-quality requirements for industrial applications are highly variable; however, hardness is a property that affects the usefulness of water for many industrial purposes. Excessive hardness is objectionable because it contributes to the formation of scale in steam boilers, water heaters, radiators, and other equipment where water is heated, evaporated, or treated with alkaline materials. The base flow of streams throughout the area studied meets the quality requirements for many industrial uses, but water in most streams will require softening for some industrial applications.

Surface water for irrigation in the study area is being used primarily for the supplemental irrigation of pastures and fields producing feed, forage, cotton, and vegetables. The base flow of streams throughout the study area is satisfactory for this type of irrigation. Prolonged use of the base flow from the upper reach of the Lampasas River is not advisable, however, unless drainage is good, salinity control measures are practiced, and crops with good salt tolerance are selected.

The chemical-quality data discussed in this report were collected during a period when most of the streamflow was sustained by effluent ground water; consequently, the concentrations of dissolved constituents probably were near maximum. Flood runoff will have much lower concentrations.

## SUMMARY AND CONCLUSIONS

Both the Leon and Lampasas Rivers generally gained flow throughout the reaches studied. Flow in the Leon River increased from 4.46 cfs at mile 16.7 to about 58 cfs at mile 0.0, a net gain of 53.5 cfs. During the study, the city of Temple diverted an average of 6.1 cfs from the Leon River. Thus, the gross gain in flow totaled 59.6 cfs. Measured inflow from tributaries was 50.9 cfs, or about 85 percent of the total gain in mainstream flow. Direct accretions of ground water in the upper 4.4-mile reach of the mainstream probably accounted for much of the unmeasured gain. Much of the drainage area in this reach is underlain by Edwards Limestone. Similarly, Nolan Creek, the principal contributor of inflow to the lower reach of the river, is underlain mostly by Edwards Limestone. Inflow from Nolan Creek was 24.7 cfs, or about 49 percent of the total inflow from tributaries.

The dissolved-solids content of water in the Leon River increased from 253 mg/l at mile 16.7 to more than 400 mg/l in the reach below the confluence of Nolan Creek. Inflow from Nolan Creek contained 460 mg/l dissolved solids and accounted for much of the increase in mineralization of the main stem. Principal dissolved constituents in waters of the Leon River, Nolan Creek, and most of the other tributaries were calcium and bicarbonate.

Flow in the Lampasas River increased from 24.6 cfs at mile 15.8 to 112 cfs at mile 0.1, a gain of 87.4 cfs. Measured tributary inflow was 71.5 cfs, or about 82 percent of the total gain. Salado Creek, which is underlain mostly by Edwards Limestone, contributed 70.2 cfs, or more than 80 percent of the total gain in main-stem flow.

The concentration of dissolved solids in the Lampasas River decreased from 660 mg/l at mile 15.8 to 385 mg/l at mile 0.1, and the water was altered in chemical character from a sodium chloride type at the upstream site to a calcium bicarbonate type at the downstream site. Much of the decrease in dissolved-solids content and change in chemical character resulted from the inflow of water from Salado Creek. Water contributed by Salado Creek contained 275 mg/l dissolved solids and was of calcium bicarbonate type.

The concentrations of dissolved solids, chloride, and sulfate in water throughout the area studied, except the upper reach of the Lampasas River, were within the U.S. Public Health Service suggested limits for water to be used as a municipal supply. In the upper reach of the Lampasas River, the suggested limits for dissolved solids and chloride were exceeded, but not greatly; the maximum concentrations of dissolved solids and chloride were 698 mg/l and 305 mg/l, respectively.

The base flow in streams throughout the area meets the quality requirements for many industrial uses, but water in most streams will require softening for some industrial applications. Moreover, the base flow generally is suitable for the supplemental irrigation of most crops grown in the study area.

## REFERENCES


Adkins, W. S., and Arick, M. B., 1930, Geology of Bell County, Texas: Univ. Texas, Bur. Econ. Geology Bull. 3016, 92 p., map.

Mills, W. B., and Rawson, Jack, 1965, Base-flow studies, Lampasas River, Texas, quantity and quality, June 3-6, 1963: Texas Water Comm. Bull. 6506, 16 p., 2 pls., 4 figs.

U.S. Public Health Service, 1962, Public Health Service drinking water standards: U.S. Public Health Service Pub. 956, 61 p., 1 fig.

Table 1.—Summary of Discharge Measurements—Leon, Lampasas, and Little Rivers and Tributaries, January 16-17, 1968

(All Tributaries were Inspected. Those with No Flow are not Listed in This Table.)

| SITE | DATE (JAN. 1968) | STREAM | LOCATION | RIVER MILE | WATER TEMP. °C | WATER TEMP. °F | DISCHARGE IN CFS MAIN STREAM | DISCHARGE IN CFS TRIBUTARY | STREAMBED |
|---|---|---|---|---|---|---|---|---|---|
| | | | LEON RIVER AND TRIBUTARIES | | | | | | |
| 1 | 16 | Leon River | 300 ft below Belton Dam | 16.7 | 8 | 46 | 4.46 | – | Man-made channel |
| 2 | 16 | Dunns Canyon | At mouth | a16.5 | 7 | 45 | – | 0.06 | Caliche and gravel |
| 3 | 16 | Unnamed tributary | At mouth | a15.9 | 8 | 46 | – | .08 | Rock |
| 4 | 16 | Unnamed tributary | At mouth | a15.5 | 18 | 64 | – | 1.11 | Silt and gravel |
| 5 | 16 | Unnamed spring | On right bank of Leon River Leon River near Belton | a15.5 | 17 | 63 | – | .12 | Limestone |
| 6 | 16 | Leon River | At stream-gaging station 8-1025, Leon River near Belton | 12.3 | 14 | 57 | 9.19 | – | Limestone |
| 7 | 16 | Pepper Creek | At Interstate Highway 35 | a10.9 | 8 | 46 | – | 10.9 | Gravel |
| 8 | 16 | Bird Creek | 600 ft above mouth | a8.9 | 11 | 52 | – | 8.39 | Sandy loam |
| 9 | 16 | Nolan Creek | At mouth | a8.1 | 8 | 46 | – | 24.7 | Sand and gravel |
| 10 | 16 | Unnamed tributary | Below Nolan Creek | a7.9 | 7 | 45 | – | .24 | Clay |
| 11 | 17 | Leon River | 1,000 ft below Nolan Creek | a7.7 | 8 | 46 | 52.3 | – | Rock overlain with gravel |
| 12 | 17 | Fryers Creek | 1,500 ft above mouth | a3.3 | 11 | 52 | – | 5.30 | Gravel |
| 13 | 17 | Unnamed tributary | 1,600 ft above mouth | a2.7 | 8 | 46 | – | .02 | Gravel and rock |
| | | | LAMPASAS RIVER AND TRIBUTARIES | | | | | | |
| 14 | 16 | Lampasas River | 1,500 ft below Stillhouse Hollow Dam (under construction) | 15.8 | 6 | 43 | 24.6 | – | Gravel |
| 15 | 16 | Lampasas River | At stream-gaging station 8-1041, Lampasas River near Belton | 13.2 | – | – | 32.8 | – | Limestone and gravel |
| 16 | 16 | Lampasas River | At Farm Road 1123, 5 mi southeast of Belton | 4.8 | – | – | 38.0 | – | Gravel and small rocks |
| 17 | 16 | Mitchell Branch | At Farm Road 1123, 3 mi southeast of Belton | a3.1 | 9 | 48 | – | 1.32 | Silt and gravel |
| 18 | 16 | Salado Creek | 500 ft above mouth | a.9 | – | – | – | 70.2 | Silt and sand |
| 19 | 16 | Lampasas River | 500 ft above confluence with Leon River | .1 | 9 | 48 | 112 | – | Rock |
| | | | LITTLE RIVER | | | | | | |
| 20 | 17 | Little River | 1,300 ft below confluence of Leon and Lampasas Rivers | 102 | 9 | 48 | 170 | – | Rock overlain by sand |

[a] River mile on Leon River at mouth of tributary.

[b] River mile on Lampasas River at mouth of tributary.

Table 2.-Chemical Analyses of the Leon, Lampasas, and Little Rivers and Tributaries, January 16-17, 1968

(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 ($NO_3$) | DISSOLVED SOLIDS (CALCULATED) | HARDNESS AS $CaCO_3$ CALCIUM, MAGNESIUM | HARDNESS AS $CaCO_3$ NONCARBONATE | SODIUM ADSORPTION RATIO | SPECIFIC CONDUCTANCE (MICROMHOS AT 25°C) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LEON RIVER AND TRIBUTARIES** | | | | | | | | | | | | | | | | | | |
| 1 | Leon River | Jan. 16 | 4.46 | 6.8 | 48 | 10 | 28 | 3.9 | 161 | 31 | 46 | 0.4 | 0.2 | 253 | 161 | 29 | 1.0 | 452 | 7.5 |
| 2 | Dunns Canyon | do | .06 | 13 | 58 | 12 | 25 | .7 | 178 | 44 | 39 | .2 | 2.2 | 282 | 194 | 48 | .8 | 489 | 7.5 |
| 3 | Unnamed tributary to Leon River | do | .08 | 9.1 | 40 | 22 | 7.5 | .8 | 203 | 14 | 14 | .3 | 13 | 221 | 190 | 24 | .2 | 395 | 7.7 |
| 4 | Unnamed tributary to Leon River | do | 1.11 | 8.8 | 42 | 10 | 4.3 | .6 | 134 | 11 | 8.3 | .4 | 27 | 178 | 146 | 36 | .2 | 303 | 7.8 |
| 5 | Unnamed spring | do | .12 | 17 | 34 | 24 | 45 | 1.3 | 226 | 32 | 38 | .7 | 14 | 317 | 184 | 0 | 1.4 | 545 | 7.8 |
| 6 | Leon River | do | 9.19 | 7.8 | 60 | 11 | 36 | 2.6 | 209 | 36 | 42 | .4 | 6.9 | 306 | 194 | 23 | 1.1 | 533 | 7.8 |
| 7 | Pepper Creek | do | 10.9 | 7.8 | 64 | 2.0 | 14 | 1.8 | 142 | 43 | 19 | .4 | 15 | 237 | 168 | 52 | .5 | 394 | 7.5 |
| 8 | Bird Creek | do | 8.39 | 7.9 | 82 | 3.6 | 76 | 3.4 | 238 | 83 | 70 | .6 | 7.8 | 451 | 220 | 24 | 2.2 | 755 | 7.8 |
| 9 | Nolan Creek | Jan. 17 | 24.7 | 7.3 | 88 | 11 | 61 | 5.4 | 263 | 58 | 65 | 2.6 | 33 | 460 | 264 | 49 | 1.6 | 777 | 7.6 |
| 10 | Unnamed tributary to Leon River | do | .24 | 8.3 | 78 | 2.5 | 43 | 1.1 | 147 | 48 | 73 | .2 | 27 | 353 | 205 | 84 | 1.3 | 612 | 7.2 |
| 11 | Leon River | do | 52.3 | 7.3 | 90 | 7.7 | 54 | 4.2 | 258 | 58 | 57 | 1.3 | 22 | 428 | 256 | 44 | 1.5 | 711 | 8.2 |
| 12 | Fryers Creek | Jan. 16 | 5.30 | 9.4 | 62 | 2.8 | 16 | 1.3 | 156 | 35 | 24 | .5 | 6.9 | 235 | 166 | 38 | .5 | 398 | 7.5 |
| 13 | Unnamed tributary to Leon River | Jan. 17 | .02 | 8.3 | 74 | 2.7 | 17 | 3.0 | 172 | 38 | 27 | .4 | 18 | 273 | 196 | 55 | .5 | 459 | 7.6 |
| | **LAMPASAS RIVER AND TRIBUTARIES** | | | | | | | | | | | | | | | | | | |
| 14 | Lampasas River | Jan. 16 | 24.6 | 3.6 | 54 | 31 | 150 | 5.0 | 162 | 25 | 305 | 0.3 | 6.6 | 660 | 262 | 129 | 4.0 | 1,280 | 7.7 |
| 15 | do | do | 32.8 | 4.0 | 74 | 31 | 145 | 4.9 | 221 | 24 | 298 | .3 | 8.0 | 698 | 312 | 131 | 3.6 | 1,330 | 7.7 |
| 16 | do | do | 38.0 | 4.8 | 64 | 28 | 120 | 4.1 | 211 | 25 | 235 | .4 | 9.5 | 595 | 274 | 102 | 3.2 | 1,130 | 7.5 |
| 17 | Mitchell Branch | do | 1.32 | 6.2 | 71 | 2.1 | 18 | 1.3 | 149 | 30 | 36 | .3 | 26 | 264 | 186 | 64 | .6 | 456 | 7.4 |

Table 2.-Chemical Analyses of the Leon, Lampasas, and Little Rivers and Tributaries, January 16-17, 1968-Continued

(Results in Milligrams per Liter Except as Indicated)

| SITE | STREAM | DATE OF COLLECTION (1968) | DISCHARGE (cfs) | SILICA ($SiO_4$) | CAL-CIUM (Ca) | MAG-NE-SIUM (Mg) | SODIUM (Na) | PO-TAS-SIUM (K) | BI-CAR-BON-ATE ($HCO_3$) | SULFATE ($SO_4$) | CHLORIDE (Cl) | FLUO-RIDE (F) | NI-TRATE ($NO_3$) | DISSOLVED SOLIDS (CALCULATED) | HARDNESS AS $CaCO_3$ CAL-CIUM, MAG-NE-SIUM | HARDNESS AS $CaCO_3$ NON-CAR-BON-ATE | SO-DIUM AD-SORP-TION RATIO | SPECIFIC CON-DUCT-ANCE (MICRO-MHOS AT 25°C) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | Salado Creek | do | 70.2 | 7.5 | 69 | 12 | 13 | 1.3 | 212 | 28 | 20 | 0.3 | 20 | 275 | 222 | 48 | 0.4 | 476 | 7.5 |
| 19 | Lampasas River | do | 112 | 6.5 | 67 | 17 | 51 | 2.3 | 212 | 28 | 98 | .3 | 11 | 385 | 237 | 68 | 1.6 | 643 | 7.5 |
| | | | | | | | | LITTLE RIVER | | | | | | | | | | | |
| 20 | Little River | Jan. 17 | 170 | 6.8 | 88 | 14 | 48 | 2.8 | 260 | 37 | 81 | .6 | 16 | 422 | 277 | 64 | 1.3 | 732 | 7.8 |