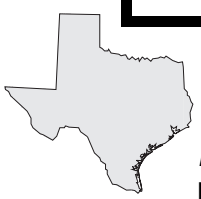
ANALYSIS OF MINIMUM 7-DAY DISCHARGES AND ESTIMATION OF MINIMUM 7-DAY, 2-YEAR DISCHARGES FOR STREAMFLOW-GAGING STATIONS IN THE BRAZOS RIVER BASIN, TEXAS

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 97–4117



Prepared in cooperation with the
BRAZOS RIVER AUTHORITY

ANALYSIS OF MINIMUM 7-DAY DISCHARGES AND ESTIMATION OF MINIMUM 7-DAY, 2-YEAR DISCHARGES FOR STREAMFLOW-GAGING STATIONS IN THE BRAZOS RIVER BASIN, TEXAS

By Timothy H. Raines and William H. Asquith

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 97–4117

Prepared in cooperation with the
BRAZOS RIVER AUTHORITY

Austin, Texas
1997

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Acting Director

For additional information write to:

District Chief
U.S. Geological Survey
8011 Cameron Rd.
Austin, TX 78754–3898

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, CO 80225–0286

CONTENTS

Abstract 1
Introduction 1
Purpose and Scope 2
Physical Setting 2
Methods of Analysis 3
N-Day Analysis 4
Statistical Analysis 4
Frequency Analysis 5
Acknowledgments 5
Analysis of Minimum 7-Day Discharges 5
Mann-Kendall Test 5
Wilcoxon Rank-Sum Test 11
Estimation of Minimum 7-Day, 2-Year Discharges 11
Stations With Unregulated Discharge Only 11
Stations With Regulated Discharge Only 11
Stations With Both Unregulated and Regulated Discharge 11
Summary 13
References Cited 14

PLATE

(Plate is in pocket)

1. Map showing locations of streamflow-gaging stations in the Brazos River Basin, Texas

FIGURES

1. Map showing location of the Brazos River Basin, Texas 3
2. L-moment diagram for unregulated and regulated streamflow-gaging stations, Brazos River Basin, Texas 6

3–10. Graphs showing annual minimum 7-day discharges for station:
3. 08099300 Sabana River near De Leon, Texas, water years 1961–86 7
4. 08083100 Clear Fork Brazos River near Roby, Texas, water years 1963–93 7
5. 08150000 Big Creek near Needville, Texas, water years 1948–95 9
6. 08093100 Brazos River near Aquilla, Texas, water years 1941–95 9
7. 08082000 Salt Fork Brazos River near Aspermont, Texas, water years 1940–95 10
8. 08091000 Brazos River near Glen Rose, Texas, water years 1924–95 10
9. 08096500 Brazos River at Waco, Texas, water years 1897–1995 12
10. 08091500 Paluxy River at Glen Rose, Texas, water years 1948–95 12

TABLES

1. Reservoirs with normal storage capacities exceeding 5,000 acre-feet, Brazos River Basin, Texas 15
2. Streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data, Brazos River Basin, Texas 17
3. Mann-Kendall test results of annual minimum 7-day discharges for streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data 21
4. Wilcoxon rank-sum test results of annual minimum 7-day discharges for streamflow-gaging stations with at least 10 years each of unregulated and regulated discharge data 25
5. Estimated minimum 7-day, 2-year discharges for streamflow-gaging stations, Brazos River Basin, Texas 26

Analysis of Minimum 7-Day Discharges and Estimation of Minimum 7-Day, 2-Year Discharges for Streamflow-Gaging Stations in the Brazos River Basin, Texas

By Timothy H. Raines *and* William H. Asquith

Abstract

The minimum 7-day, 2-year discharge (7Q2) was estimated for each of 97 streamflow-gaging stations in the Brazos River Basin, Texas, with at least 10 years of unregulated or 10 years of regulated discharge data using the Pearson Type III distribution fitted by L-moment statistics of the annual minimum 7-day discharges. Forty-six stations have at least 10 years of unregulated discharge data only, 26 stations have at least 10 years of regulated discharge data only, and 25 stations have at least 10 years of unregulated and 10 years of regulated discharge data.

Statistical tests were applied to the annual minimum 7-day discharges to determine if the unregulated and regulated data have trends; and to determine if the data before regulation are significantly different from the data after regulation. Results of the Mann-Kendall test indicate a significant trend at the 95-percent confidence level for 8 of the 46 unregulated-only stations, for 6 of the 26 regulated-only stations, and for 5 stations before regulation and for 10 stations after regulation of the 25 stations with both unregulated and regulated data. Results of the Wilcoxon rank-sum test indicate a significant difference between the unregulated and regulated annual minimum 7-day discharges at the 95-percent confidence level for 16 of the 25 stations with both types of data.

The 7Q2 is zero for 31 of the 46 unregulated-only stations and for 9 of the 26 regulated-only stations. The 7Q2 also is zero for 9 stations before regulation and for 3 stations after regulation of the 25 stations with both unregulated and regulated data. The 7Q2 ranges from 33 to 631 cubic feet per second for the eight regulated-only stations on the mainstem Brazos River. For the seven stations on the mainstem Brazos River with at least 10 years of unregulated and 10 years of regulated discharge data, the 7Q2 ranges from 0 to 568 cubic feet per second before regulation and from 0.30 to 670 cubic feet per second after regulation. The 7Q2 increased during regulation for 19 of the 25 stations with both unregulated and regulated data. The effect of regulation for most stations generally was an increase in the magnitude of the 7Q2.

INTRODUCTION

Low-flow characteristics of streams are useful to evaluate the effects that proposed or existing withdrawals or return flows might have on the streamflow and water quality in the basin. Hundreds of permits for withdrawals and return flows now exist for streams in the Brazos River Basin in Texas, and many new permits are expected to be requested in the future. The effect that these withdrawals and the return flows have on the flow and water quality of receiving streams in the basin is unknown. The minimum 7-day, 2-year discharge[1] (7Q2) is useful in assessing these possible effects. The 7Q2 is used by the Texas Natural Resource Conservation Commission to analyze permit applications. Several reservoirs have been constructed in the basin for flood protection, water supply, and recreation. The effect that the reservoirs have on the low-flow discharge also is unknown. No known previous studies of low-flow frequency have been done for the Brazos River Basin.

[1]Annual lowest mean discharge for 7 consecutive days with a 2-year recurrence interval.

In 1996 the U.S. Geological Survey (USGS), in cooperation with the Brazos River Authority (BRA) conducted a study to determine the 7Q2 for streamflow-gaging stations in the Brazos River Basin using annual minimum 7-day discharges. The objectives of the study were to (1) determine the 7Q2 for the 97 stations with at least 10 years of unregulated or 10 years of regulated data, (2) determine the 7Q2 for the unregulated period and regulated period of the 25 stations with at least 10 years of discharge data both before and after regulation, and (3) determine the effects of regulation on the 7Q2 for the 25 stations.

Purpose and Scope

This report presents an analysis of minimum 7-day discharges and estimates of 7Q2 for unregulated and regulated streamflow-gaging stations in the Brazos River Basin and documents the effect of regulation on the 7Q2. This report is limited to the 97 streamflow-gaging stations with at least 10 years of unregulated or regulated daily discharge data through water year[2] 1995. Statistical tests were applied to the annual minimum 7-day discharges. The Mann-Kendall test for monotonic trends[3] was applied separately to the unregulated and regulated annual minimum 7-day discharges for all 97 stations. The Wilcoxon rank-sum test for significant differences between the median of groups was applied to the 25 stations with at least 10 years of discharge data before and after regulation. The Pearson Type III probability distribution was used to estimate the 7Q2 for the unregulated and regulated discharge data for all 97 streamflow-gaging stations.

Physical Setting

The Brazos River Basin drains about 45,000 square miles (mi^2), of which more than 35,000 mi^2 are contributing, and extends from northwest Texas to the Gulf of Mexico (fig. 1). Mean annual precipitation, mostly as rainfall, ranges from about 16 inches (in.) in the northwestern part of the basin to 51 in. at the mouth and generally increases from west to east (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1990). The periods of minimum flow generally occur in July and August due to low precipitation and high evapotranspiration. Statewide droughts during 1932–34, 1938–40, 1947–48, 1950–57, and 1960–67 (Riggio and others, 1987) affected the entire Brazos River Basin. The magnitude and duration of droughts vary over the State. During some droughts only certain regions of Texas are affected. The most severe recorded drought in recent history occurred during 1950–57 and reached its greatest magnitude in the summer of 1956. Several less severe droughts during the 1970s and early 1980s affected only parts of the Brazos River Basin.

Thirty-nine reservoirs with normal storage capacities (generally the top of the conservation pool) that exceed 5,000 acre-feet (acre-ft) have been constructed in the Brazos River Basin (table 1 at end of report); 10 have a normal storage capacity that exceeds 100,000 acre-ft. Three of the 39 reservoirs are located on the mainstem Brazos River: Possum Kingdom Lake, Lake Granbury, and Lake Whitney.

The USGS has operated about 140 streamflow-gaging stations in the Brazos River Basin during various periods since 1899. Ninety-seven stations have at least 10 years of unregulated or at least 10 years of regulated daily discharge data. A regulated station is defined as having at least 10 percent of its contributing drainage area regulated by one or more reservoirs. Forty-six stations have at least 10 years of unregulated discharge data only, 26 stations have at least 10 years of regulated discharge data only, and 25 stations have at least 10 years unregulated and 10 years regulated discharge data (pl. 1). Selected characteristics of the 97 stations are listed in table 2 (at end of report). The contributing drainage areas for the 97 stations range from 8.65 to 35,773 mi^2. Fifteen stations are on the mainstem of the Brazos River and 41 stations are on 10 major tributaries: Salt Fork Brazos River, Clear Fork Brazos River, Paluxy River, Nolan River, North Bosque River, Leon River, Lampasas River, San Gabriel River, Little River, and Navasota River. For all stations, the total record ranges from 10 to 97 years; for those stations with at least 10 years each of unregulated and regulated data, the unregulated record ranges from 10 to 66 years and the regulated record ranges from 11 to 58 years. Fifty-one of the 97 stations have been discontinued or converted to partial-record stations, leaving 46 as currently (1997) active daily streamflow-gaging stations. Of the 51 stations with at least 10 years of regulated data, 41 stations are regulated by one or more reservoirs

[2]A water year is the 12-month period from October 1 through September 30. The water year is designated by the year in which it ends; thus, the water year ending September 30, 1995, is water year 1995.

[3]A monotonic trend means that a variable (the annual minimum 7-day discharge in this report) increases or decreases over time, but not necessarily linearly.

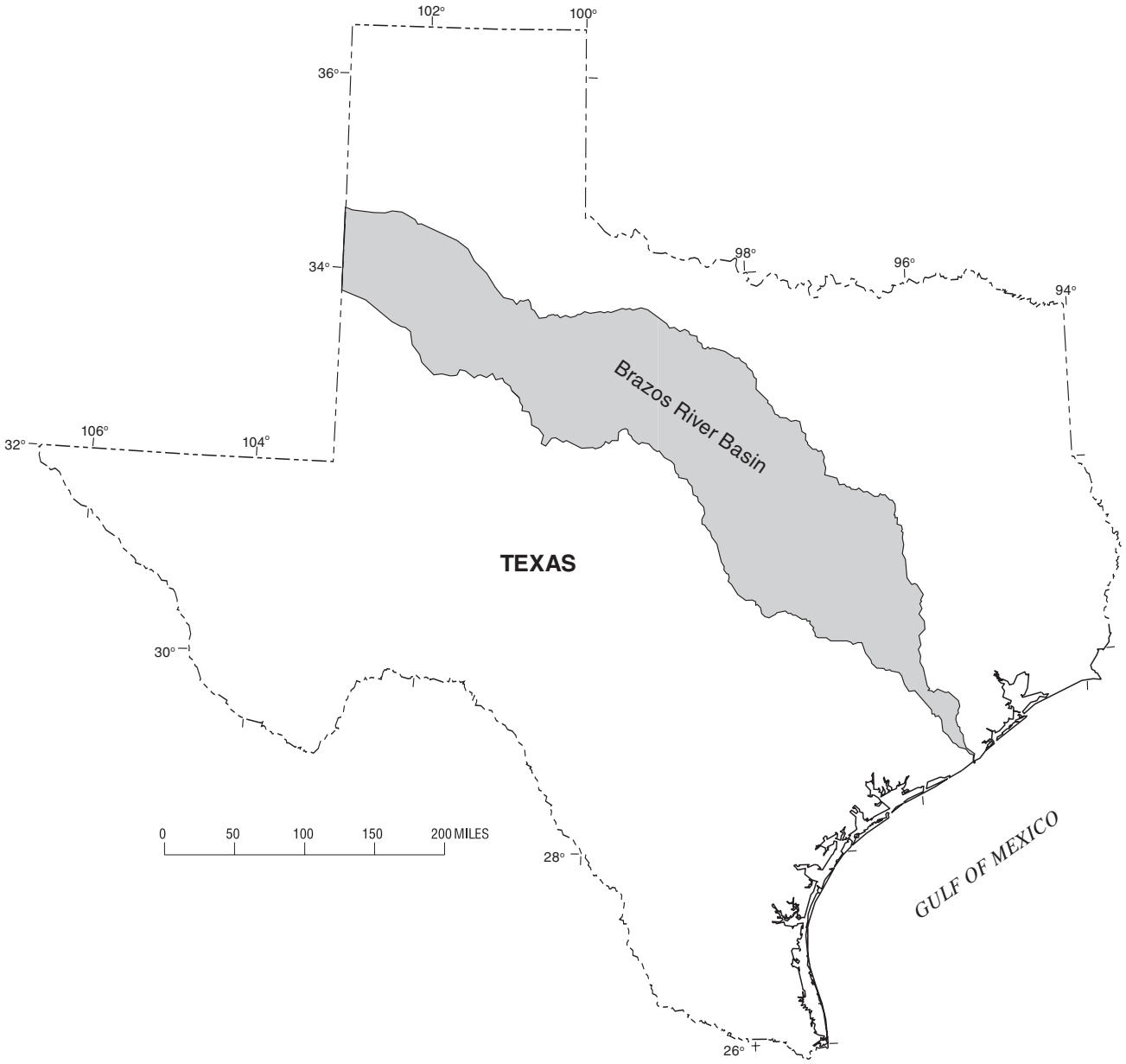


Figure 1. Location of the Brazos River Basin, Texas.

listed in table 1. The remaining 10 stations are regulated by flood-retarding structures with normal storage capacities less than 5,000 acre-ft. The areal extent of regulation—the percent drainage area considered regulated—ranges from 11.1 to 99.8 percent.

Methods of Analysis

The annual minimum 7-day discharges were computed from daily mean discharge data for the streamflow-gaging stations. Statistical tests were applied to the annual minimum 7-day discharges to identify trends in the unregulated and regulated discharge data and significant differences between the unregulated and regulated discharge data. The 7Q2 for each station was estimated by fitting the annual minimum 7-day discharges to a probability distribution. The station 7Q2 was estimated as the discharge for a 2-year recurrence interval (0.50 exceedance probability). Several different probability distributions were

examined to select the most appropriate distribution for the frequency of minimum 7-day discharges in the Brazos River Basin. The results of the statistical analysis and the frequency analysis were used to determine the effect of reservoirs on the 7Q2.

N-Day Analysis

N-day discharges are computed as the mean of N consecutive daily mean discharges. The annual minimum 7-day discharge is the minimum mean of any seven consecutive daily mean discharges in each water year. Each successive water year was analyzed to generate a time series of annual minimum 7-day discharges for a station. The 7-day analysis was performed using the period of record for each of the 97 streamflow-gaging stations.

Statistical Analysis

The low-flow discharge of a regulated stream might be affected by the operation of an upstream reservoir. Such effects might not be consistent from year to year depending upon the timing and magnitude of reservoir releases. This inconsistency might affect the frequency-analysis assumption that the low-flow discharges are independent. For this reason, frequency analysis typically is used only on unregulated (natural) streams. However, frequency analysis can be used meaningfully on regulated streams if no significant temporal trends exist in the regulated record and if the operational policies remain constant for the period. It is also desirable to test unregulated discharge data for temporal trends due to natural causes that could affect the assumption of independence among low-flow data.

The Mann-Kendall test (Helsel and Hirsch, 1992) was used to determine if the annual minimum 7-day discharges for unregulated and regulated periods of record have significant trends. The test is a rank-based procedure (and therefore resistant to the effect of a small number of unusual values or "outliers") used to determine whether a variable increases or decreases with time. The Mann-Kendall test in this application is a two-sided hypothesis test to indicate whether there is an increasing or decreasing trend in annual minimum 7-day discharges at the $\alpha = 0.05$ significance level. The null hypothesis (what is assumed to be true before the test) is that there is no trend; the alternative hypothesis (the situation anticipated to be true if the data show that the null hypothesis is unlikely) is that there is an increasing or decreasing trend. The null hypothesis is rejected in favor of the alternative hypothesis if the p-value[4] from the test is less than or equal to the α-level.

Setting $\alpha = 0.05$ results in a 5-percent chance that the null hypothesis will be rejected when in fact it is true—that is, the conclusion from the test is that there is a trend when the true situation is that there is no trend. Thus the confidence level of the test is 95 percent.

The test yields a correlation coefficient, Kendall's tau (τ). The value of τ is influenced by sample size and ranges from -1 to +1. τ is a measure of the strength of a trend (strength of the correlation between discharge and time). For example, if all discharges in a tested time series decrease with time, $\tau = -1$; whereas if all discharges increase with time, $\tau = +1$. The sign of τ thus indicates the direction of the trend.

If there are no significant differences between unregulated and regulated annual minimum 7-day discharges for a station, it might be appropriate to use the entire period of record for frequency analysis. The Wilcoxon rank-sum test (Helsel and Hirsch, 1992) was used to determine if the unregulated annual minimum 7-day discharges are significantly different from the regulated annual minimum 7-day discharges for the 25 stations with at least 10 years each of unregulated and regulated discharge data. The test is a rank-based procedure to determine whether two groups of data are the same (specifically, whether the two groups have the same median). The Wilcoxon rank-sum test in this application is a two-sided hypothesis test that determines for a station record whether the unregulated annual minimum 7-day discharges are the same as the regulated annual minimum 7-day discharges (same medians) at the $\alpha = 0.05$ significance level. The null hypothesis is that the unregulated and regulated discharges are the same (same medians); the alternative hypothesis is that they are different (median of unregulated discharges larger or smaller than median of regulated discharges). As in the Mann-Kendall test, the null hypothesis is rejected in favor of the alternative hypothesis if the p-value from the test is less than or equal to the α-level.

[4] The p-value is the "attained significance level" (the significance level attained by the data), which is the probability of obtaining the computed test statistic, or one even less likely, when the null hypothesis is true (Helsel and Hirsch, 1992, p. 108).

Frequency Analysis

The objective of frequency analysis of streamflow data is to relate the magnitude of extreme events to their frequency of occurrence (exceedance probability) through the use of a probability distribution. The data for each station are assumed to be independent and identically distributed. The exceedance probability also can be expressed as a return period or recurrence interval. A 2-year recurrence interval has a 50-percent exceedance probability or a 1-in-2 chance of being equaled or exceeded in any year.

Traditionally, the sample product moments (mean, variance, skewness, and kurtosis) are used to summarize the data and to fit a probability distribution. Another more recent approach is to use L-moment statistics as introduced by Hosking (1990). The sample L-moment estimates (mean, L-variance, L-skewness, and L-kurtosis) are linear combinations of the ordered data and do not involve squaring or cubing the values as do the product moments. As a result, the L-moments are almost unbiased and exhibit small sampling variance, whereas the product moments are highly biased and can exhibit large sampling variance (Stedinger and others, 1993).

An L-moment diagram illustrates the relation between L-skewness and L-kurtosis and is useful in determining the most appropriate distribution to fit to the data. Five different distributions were examined for use in this study: generalized extreme value distribution, generalized logistic distribution, generalized pareto distribution, log-normal distribution, and Pearson Type III distribution. The L-moment diagrams for the unregulated and regulated stations with five different probability distributions are shown in figure 2. The Pearson Type III distribution graphically fits the data for streamflow-gaging stations in the Brazos River Basin better than the four other probability distributions.

The Pearson Type III distribution is a three-parameter probability distribution. The L-moment statistics of the data are used to estimate the parameters of the distribution. Either the data or logarithmic transformations of the data generally are used to estimate the moments (mean, standard deviation, and skewness). The log-Pearson Type III distribution, recommended for flood frequency analyses (Interagency Advisory Committee on Water Data, 1982), uses a logarithmic transformation of the measured flood peaks. Logarithmic transformations often are effective for reducing skewness of peaks that range over orders of magnitude; but logarithmic transformations give greatly increased weight to peaks of small magnitude (low flows). However, when L-moment statistics are used, it is not necessary to use a logarithmic transformation. Also, a minimum 7-day discharge of zero is possible, which, if present, requires removal from the analysis because the logarithm of zero is undefined. A more complete description of frequency analysis using L-moments and the Pearson Type III distribution can be found in Stedinger and others (1993).

Acknowledgments

Sheryl Franklin of the BRA provided valuable review comments during preparation of the report. Glenn A. Rivers and Jessica A. Murray of the USGS assisted with the compilation and processing of the data used in this report.

ANALYSIS OF MINIMUM 7-DAY DISCHARGES

The Mann-Kendall test was used to determine if the unregulated and regulated annual minimum 7-day discharges have trends. The Wilcoxon rank-sum test was used to determine if the medians of the annual minimum 7-day discharges before regulation are significantly different from those after regulation.

Mann-Kendall Test

The Mann-Kendall test first was applied to the annual minimum 7-day discharges for the 46 stations with at least 10 years of unregulated discharge data only. A trend for an unregulated station might be the result of hydrologic variability, land-use change, or increase or decrease in withdrawals or return flows during the period of record. There is a significant trend at the 95-percent confidence level for 8 of the 46 stations (table 3 at end of report). Three different trends are apparent from graphical examination of the annual minimum 7-day discharges for the eight stations. The two stations indicating a negative trend (negative Kendall's τ), Sabana River near De Leon (fig. 3) and Big Creek near Freestone, have a few non-zero minimum 7-day discharges at the beginning of the period of record followed by a series of zero discharges. Five of the 6 stations indicating an increasing trend (positive Kendall's τ), Clear Fork Brazos River near Roby (fig. 4), California Creek near Stamford, North Fork Hubbard Creek near Albany, San Gabriel River near Circleville,

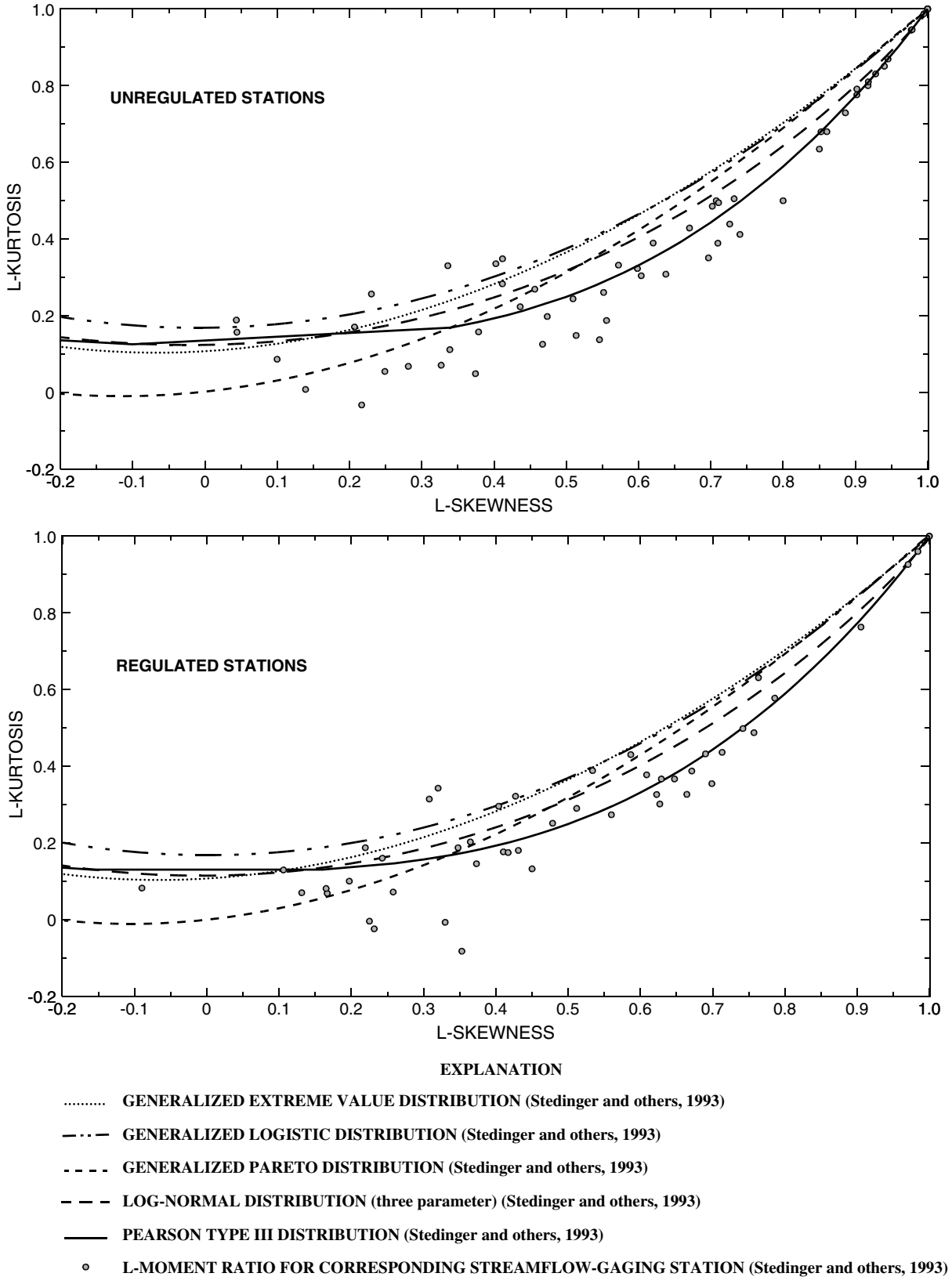


Figure 2. L-moment diagram for unregulated and regulated streamflow-gaging stations, Brazos River Basin, Texas.

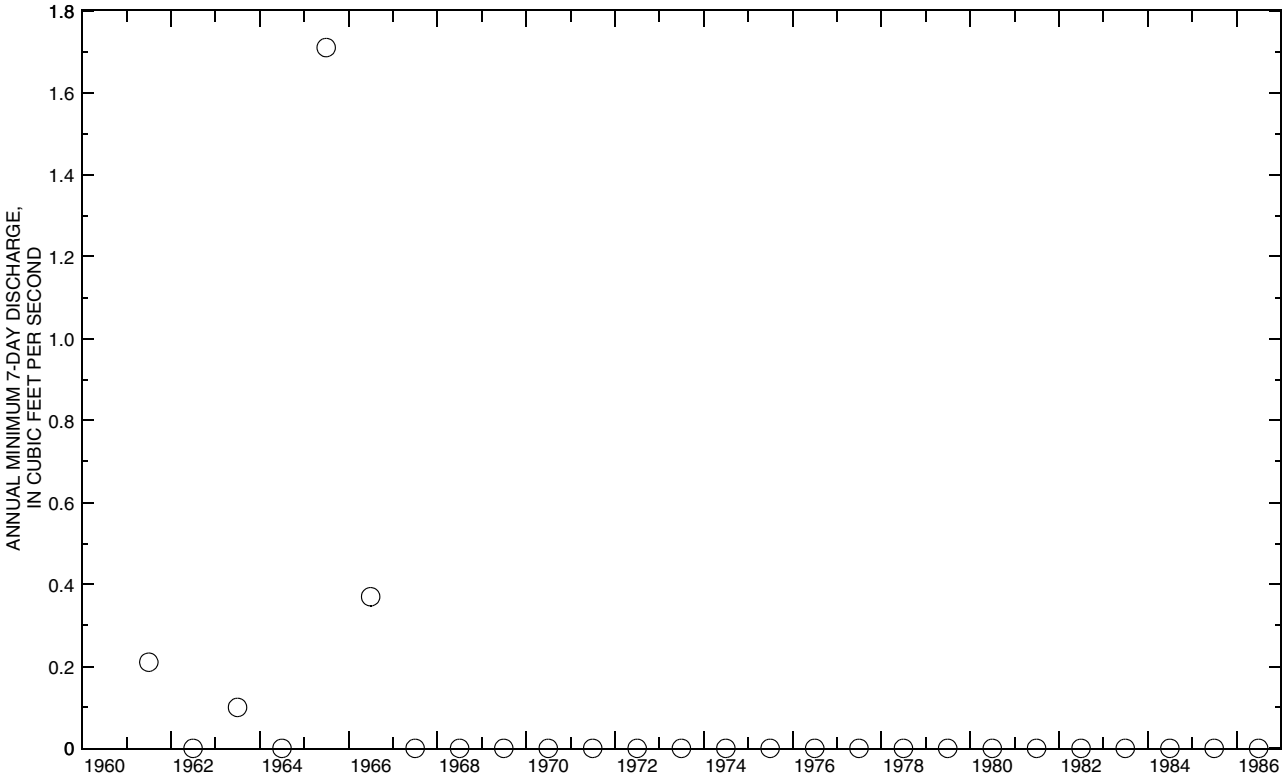


Figure 3. Annual minimum 7-day discharges for station 08099300 Sabana River near De Leon, Texas, water years 1961–86.

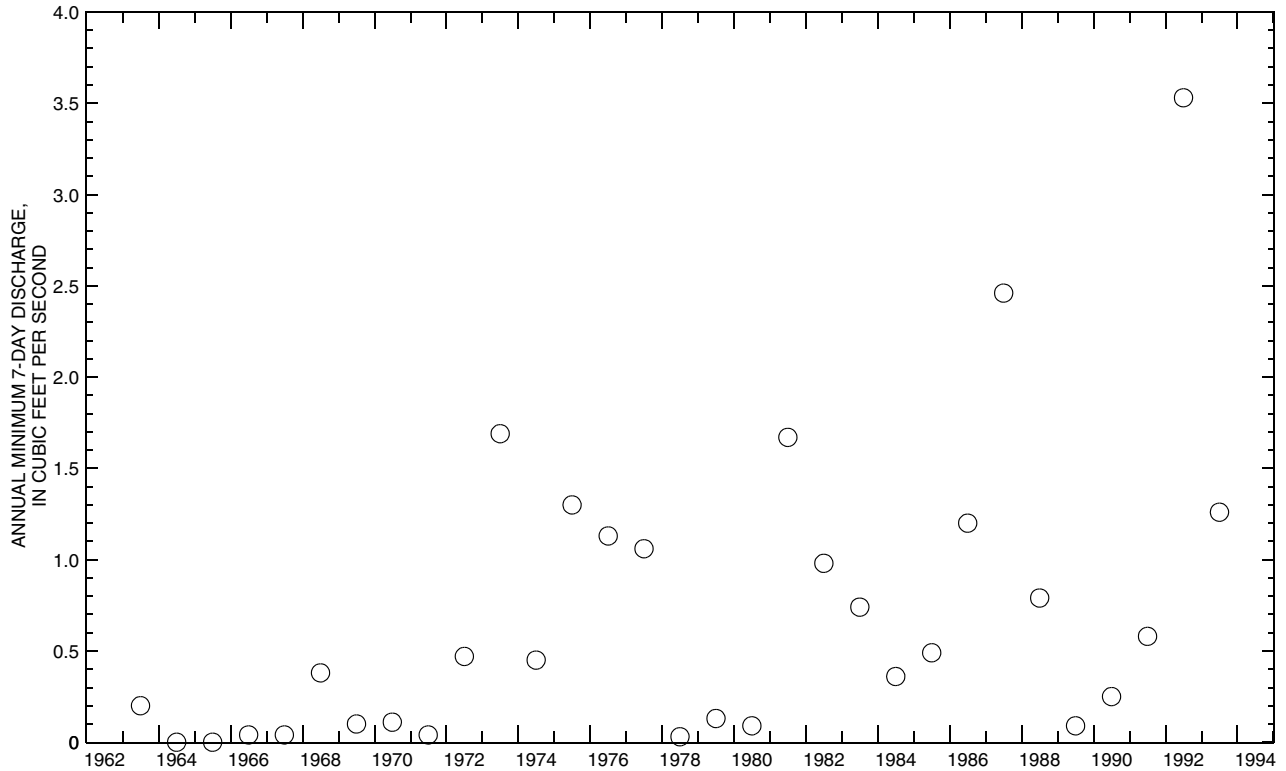


Figure 4. Annual minimum 7-day discharges for station 08083100 Clear Fork Brazos River near Roby, Texas, water years 1963–93.

and East Yegua Creek near Dime Box, have below-average minimum 7-day discharges early in the period of record (probably due to drought) and above-average discharges late in the period of record. The increasing trends for the five stations represented by the example in figure 4, Clear Fork Brazos River near Roby, probably are the result of hydrologic variability. The minimum 7-day discharges for the sixth station, Big Creek near Needville, indicate a substantially increasing trend (fig. 5), which is probably the result of land use changes during the period of record.

The Mann-Kendall test also was applied to annual minimum 7-day discharges for the 26 stations with at least 10 years of regulated discharge data only. A trend for a regulated station might be the result of hydrologic variability, addition of one or more reservoirs, or changes in operation of the reservoirs. There is a significant trend at the 95-percent confidence level for 6 of the 26 stations (table 3). Kendall's τ is negative for 1 of the 6 stations, indicating a decreasing trend. Graphical examination of the annual minimum 7-day discharges for the Brazos River near Aquilla (fig. 6) indicates a decrease in the minimum 7-day discharge during 1969–95 compared to that during 1941–68. Lake Whitney was completed in 1951 (table 1); the decrease might be the result of operational changes in the reservoir in 1969 when the conservation pool was raised. The results of the Mann-Kendall test for just the 1969–95 subset of the data for the Brazos River near Aquilla (p-value = 0.917 and $\tau = 0.017$) indicate no significant trend at the 95-percent confidence level. The remaining five stations with an increasing trend (Kendall's τ is positive), Brazos River near Dennis, North Bosque River at Hico, Leon River near Hamilton, Little River near Little River, and Brazos River near Juliff have a few minimum 7-day discharges that are below average at the beginning of the period of record and above average at the end of the period of record. The trends for the five stations are similar to the trend shown in figure 4, Clear Fork Brazos River near Roby, and probably are the result of hydrologic variability.

The Mann-Kendall test also was applied to the annual minimum 7-day discharges for the 25 stations with at least 10 years each of unregulated and regulated discharge data. The test was independently applied to unregulated and regulated annual minimum 7-day discharges. There is a significant trend at the 95-percent confidence level for unregulated data at 5 stations and for regulated data at 10 stations (table 3). For the regulated period at one additional station, Brazos River at Seymour, the weight of the evidence against the null hypothesis is nearly strong enough to reject the null hypothesis (p-value = 0.053, 94.7-percent confidence level) and conclude that a significant trend is present. Kendall's τ is negative for 2 of the 5 stations with unregulated data and for 1 of the 10 stations with regulated data.

Graphical examination of the annual minimum 7-day discharges of the five stations with unregulated data indicates the presence of two different trends based on the sign of Kendall's τ. The two stations with a negative Kendall's τ (Leon River near Hasse and Yegua Creek near Somerville) have a few non-zero minimum 7-day discharges at the beginning of the period of record followed by a series of zero discharges. The decreasing trends probably are due to hydrologic variability and are similar to the trend shown in figure 3, Sabana River near De Leon. The three stations with a positive Kendall's τ (Salt Fork Brazos River near Aspermont, Leon River at Gatesville, and Navasota River near Bryan) might be the result of minimum 7-day discharges of zero early in the unregulated period due to drought. The annual minimum 7-day discharges for the Salt Fork Brazos River near Aspermont are shown in figure 7. The unregulated period of record for this station is 1940–63.

Graphical examination of the annual minimum 7-day discharges of the 10 stations with regulated data indicates that only Brazos River near Glen Rose seems to be significantly affected by the addition of another reservoir. The minimum 7-day discharges generally are larger during roughly the first one-half of the regulated period of record (1941–69) than during roughly the second one-half of the period of record (1969–95), consistent with the negative Kendall's τ (fig. 8). The beginning of generally smaller minimum 7-day discharges coincides with the completion of Lake Granbury in 1969 (table 1). The results of the Mann-Kendall test for 1969–95 for the Brazos River near Glen Rose (p-value = 0.162 and $\tau = 0.194$) indicate no significant trend. The increasing trend for the regulated period of the remaining 9 stations (Clear Fork Brazos River at Nugent, Clear Fork Brazos River at Fort Griffin, Brazos River near South Bend, Paluxy River at Glen Rose, Aquilla Creek near Aquilla, North Bosque River near Clifton, North Fork San Gabriel River near Georgetown, Navasota River near Easterly, Brazos River at Richmond) might result from higher minimum 7-day discharges during 1990–95, which are attributed to hydrologic variability.

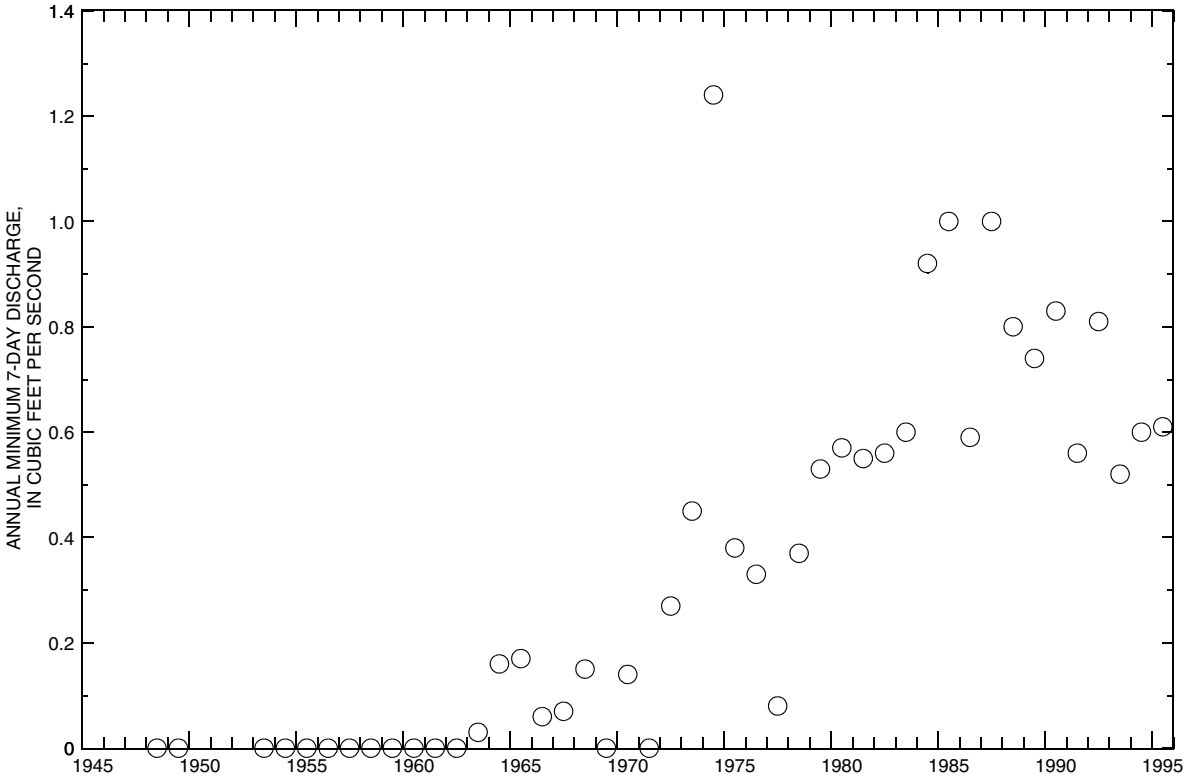


Figure 5. Annual minimum 7-day discharges for station 08150000 Big Creek near Needville, Texas, water years 1948–95.

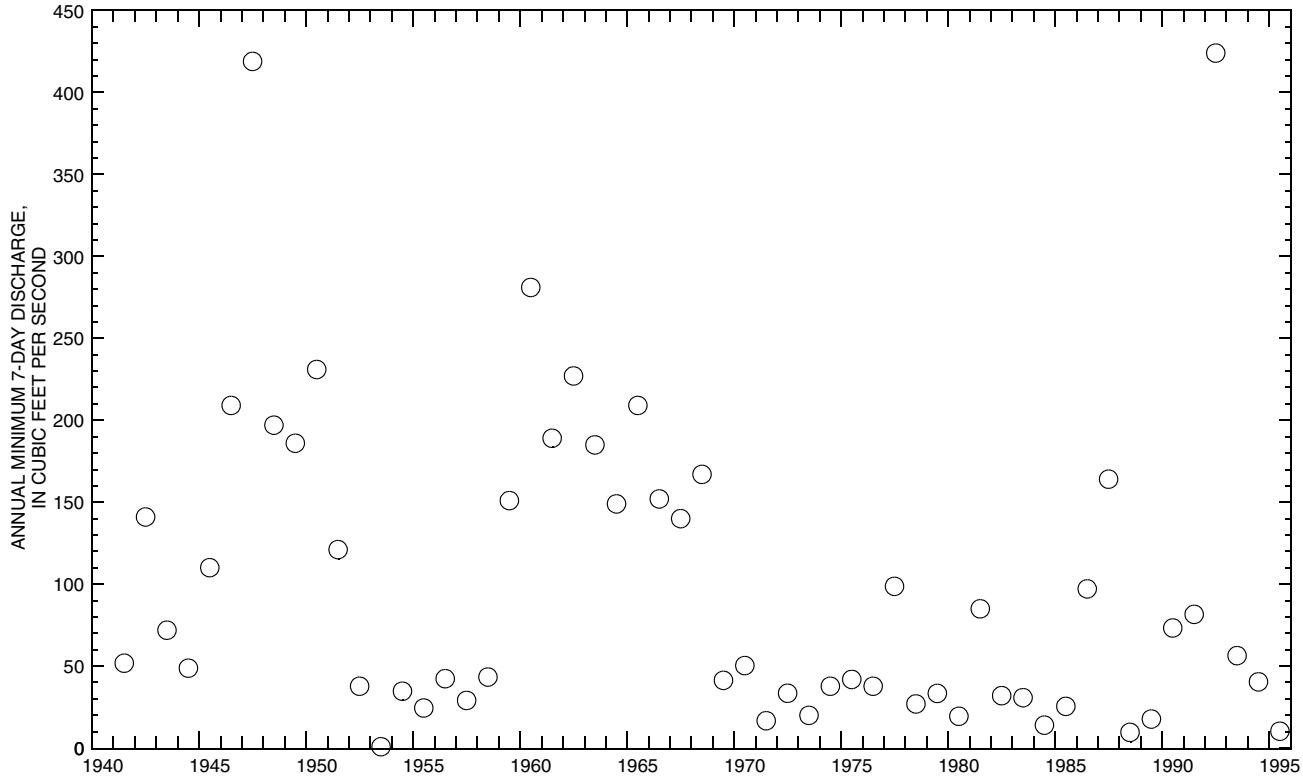


Figure 6. Annual minimum 7-day discharges for station 08093100 Brazos River near Aquilla, Texas, water years 1941–95.

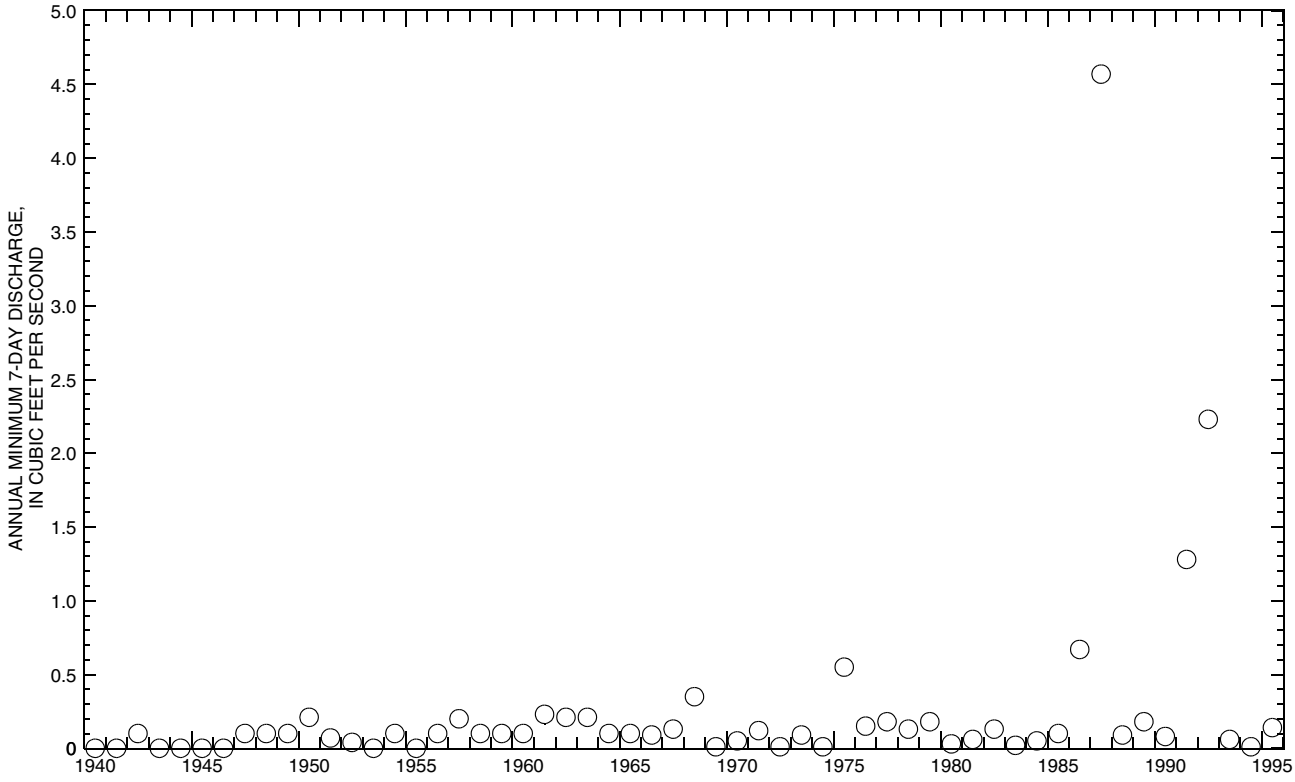


Figure 7. Annual minimum 7-day discharges for station 08082000 Salt Fork Brazos River near Aspermont, Texas, water years 1940–95.

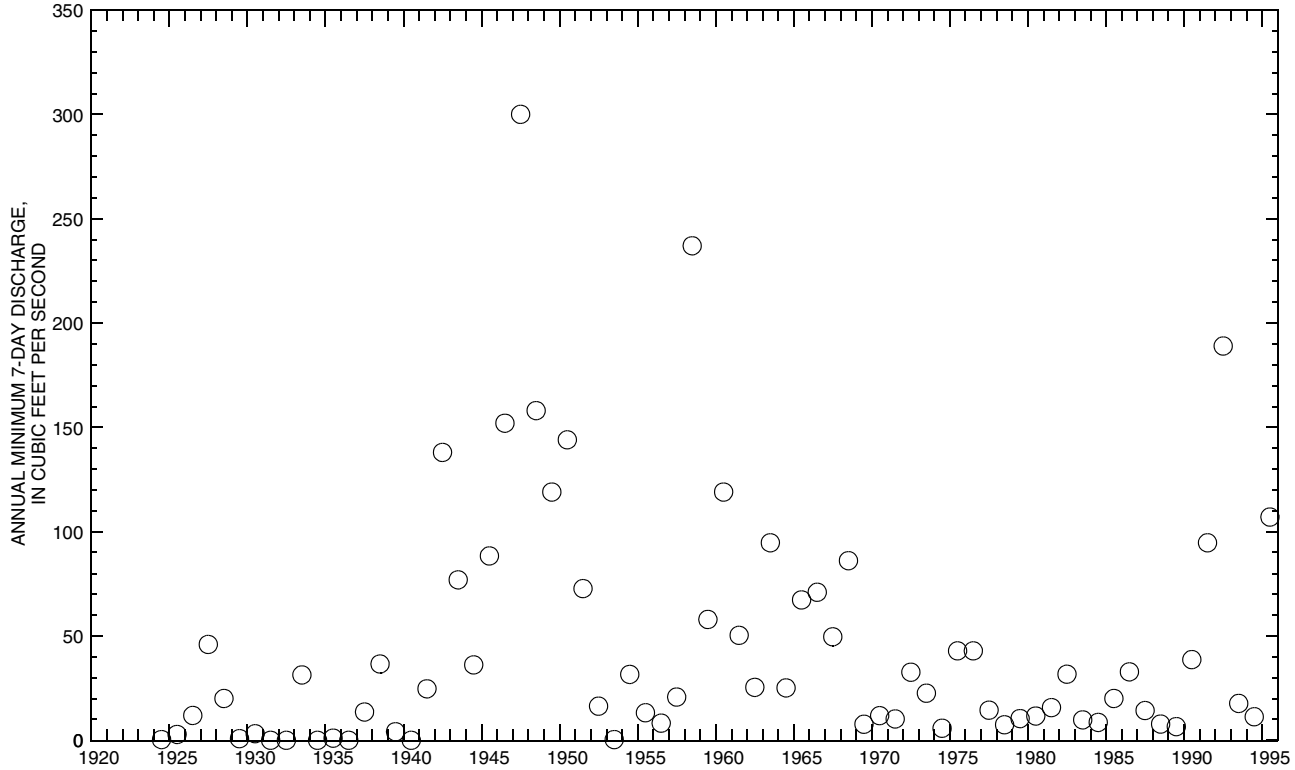


Figure 8. Annual minimum 7-day discharges for station 08091000 Brazos River near Glen Rose, Texas, water years 1924–95.

Wilcoxon Rank-Sum Test

The Wilcoxon rank-sum test was applied to annual minimum 7-day discharges for the 25 stations with at least 10 years each of unregulated and regulated discharge data (table 4 at end of report). There is a significant difference between the unregulated and regulated data at the 95-percent confidence level for 16 of the 25 stations. These significant differences most likely are caused by regulation, which might increase or decrease low flow. The graph of annual minimum 7-day discharges for Brazos River at Waco (fig. 9) is an example of a station with a significant difference between unregulated (1899–1940) and regulated (1941–95) data. The nine remaining stations show no significant difference between the unregulated and regulated annual minimum 7-day discharge data, probably because of no flow, hydrologic variability, or leakage through the dams. Also, regulation by flood-retarding structures might not significantly affect low flow. The nine stations are Salt Fork Brazos River near Aspermont (fig. 7), Clear Fork Brazos River at Nugent, Clear Fork Brazos River at Fort Griffin, Paluxy River at Glen Rose, Aquilla Creek near Aquilla, Leon River near Belton, North Fork San Gabriel River near Georgetown, Little River at Cameron, and Brazos River at Richmond. The graph of annual minimum 7-day discharges for the Paluxy River at Glen Rose (fig. 10) is an example of a station with no significant difference (p-value = 0.102) between unregulated (1942–82) and regulated (1983–95) data.

ESTIMATION OF MINIMUM 7-DAY, 2-YEAR DISCHARGES

The 7Q2 was estimated for each of the 97 streamflow-gaging stations by fitting the Pearson Type III distribution to the annual minimum 7-day discharges with a 2-year recurrence interval. The L-moment statistics of the annual minimum 7-day discharges were used to fit the Pearson Type III distribution. The 7Q2 for each unregulated and regulated period of record for the 97 streamflow-gaging stations is listed in table 5 (at end of report).

Stations With Unregulated Discharge Only

The 7Q2 is zero for 31 of the 46 stations with at least 10 years of unregulated discharge data only. Of these 31 stations, a majority of the annual minimum 7-day discharges are zero, including 14 stations with all zero annual minimum 7-day discharges. Most of these 14 stations are on minor tributaries to the Brazos River. The 7Q2 ranges from 0.02 to 2.8 cubic feet per second (ft^3/s) for 11 of the 46 unregulated stations. The 7Q2 is greater than 5 ft^3/s for 4 of the 46 unregulated stations (Lampasas River near Kempner, Lampasas River at Youngsport, San Gabriel River at Georgetown, and San Gabriel River near Circleville).

Stations With Regulated Discharge Only

Eighteen of the 26 stations with at least 10 years of regulated discharge data only are on tributaries to the Brazos River. The 7Q2 is zero for 9 stations and ranges from 0.01 to 55 ft^3/s for 9 stations. The 7Q2 values range from 28 to 631 ft^3/s for the eight regulated-only stations on the mainstem Brazos River. Of the 9 regulated-only stations with 7Q2 of zero, a majority of the annual minimum 7-day discharges are zero, including 2 stations with all zero annual minimum 7-day discharges. In contrast, of the 17 regulated stations with the 7Q2 greater than zero, a majority of the annual minimum 7-day discharges are non-zero, including 11 stations with all non-zero annual minimum 7-day discharges.

Stations With Both Unregulated and Regulated Discharge

Although the results of the Wilcoxon rank-sum test (table 4) indicate no significant difference between the unregulated and regulated annual minimum 7-day discharges for 9 of the 25 stations with both types of discharge record, the 7Q2 was estimated separately for the unregulated and regulated data for all 25 stations because the data were considered to be two independent groups. The 7Q2 is zero for the unregulated data of 9 stations and for the regulated data of 3 stations. Of the 18 stations with both types of data on tributaries to the Brazos River, the 7Q2 ranges from 0.04 to 48 ft^3/s for the unregulated data of 11 stations (the 7Q2 is zero for the other 7 stations), and the 7Q2 ranges from 0.02 to 54 ft^3/s for the regulated data of 15 stations (the 7Q2 is zero for the other 3 stations). The 7Q2 for the seven stations on the mainstem Brazos River ranges from 0 to 568 ft^3/s for unregulated data and from 0.30 to 670 ft^3/s for regulated data. The number or probability of zero annual minimum 7-day discharges decreases after regulation for most of the 25 stations.

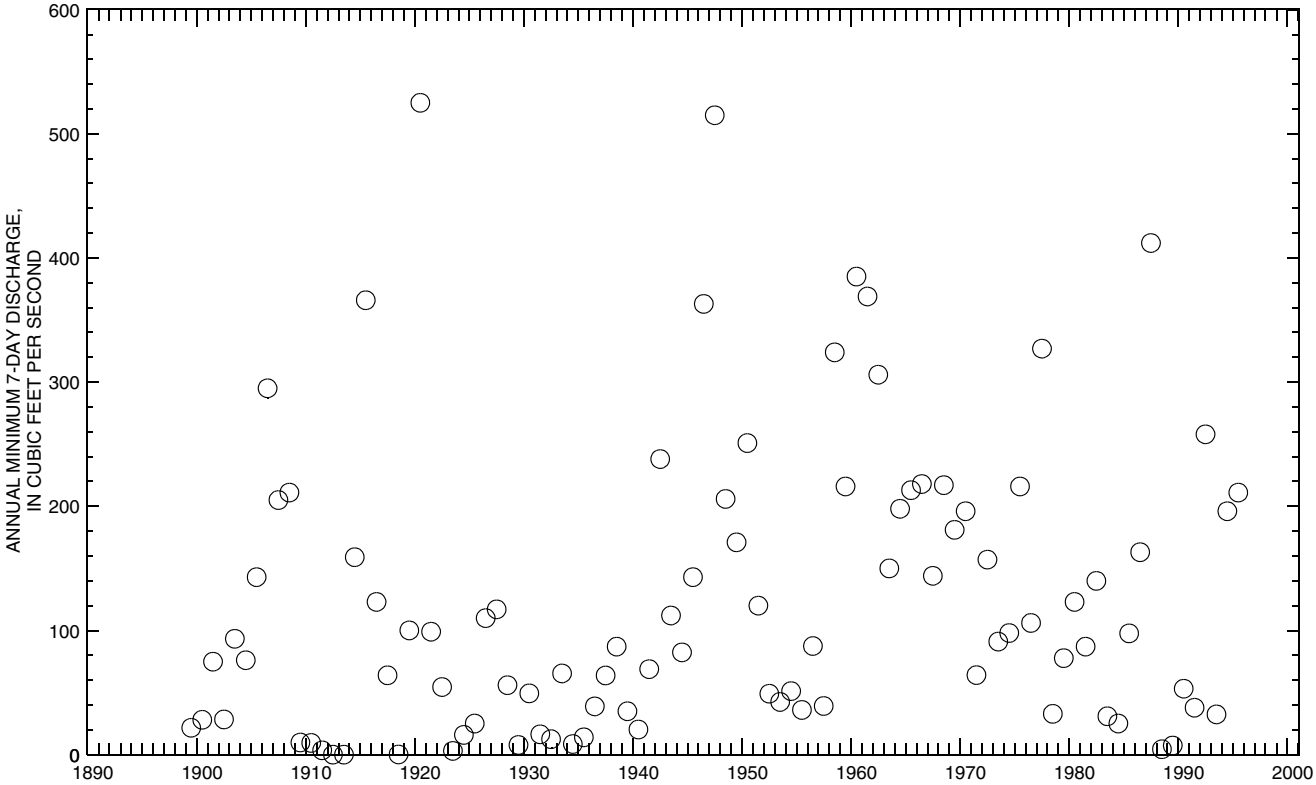


Figure 9. Annual minimum 7-day discharges for station 08096500 Brazos River at Waco, Texas, water years 1897–1995.

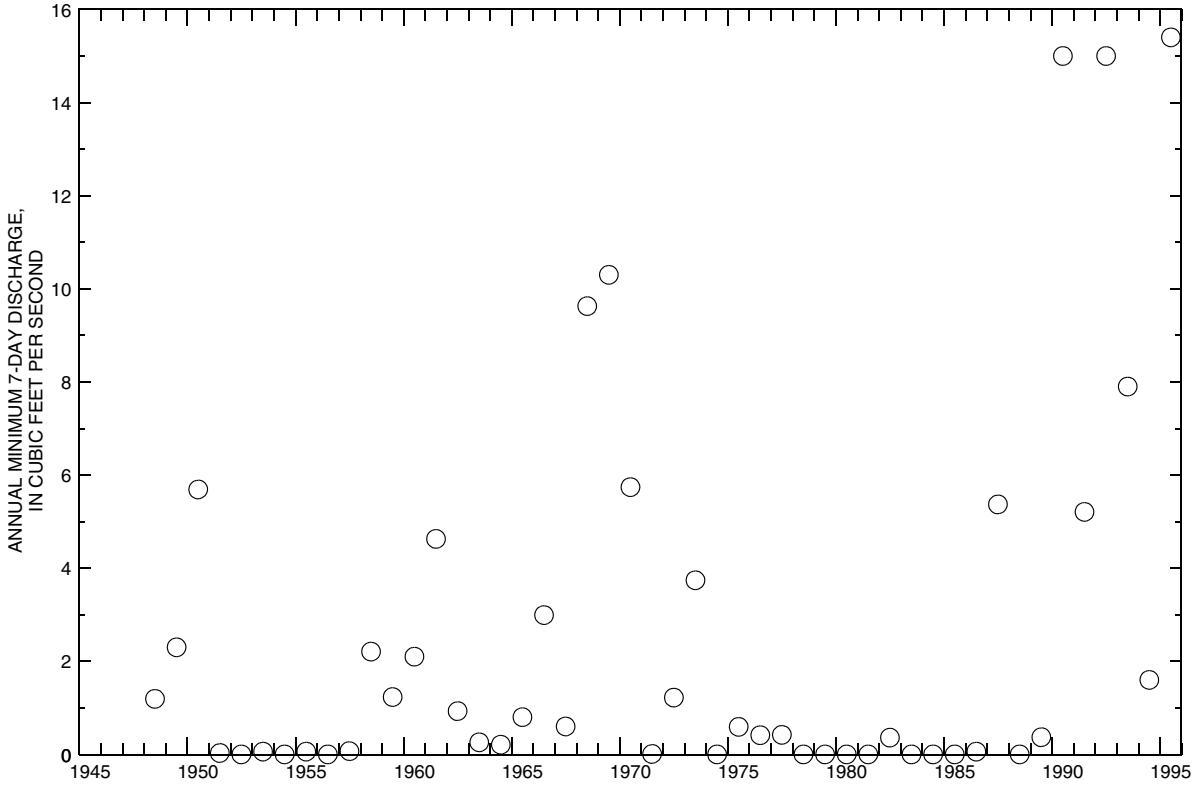


Figure 10. Annual minimum 7-day discharges for station 08091500 Paluxy River at Glen Rose, Texas, water years 1948–95.

The ratio of regulated 7Q2 to unregulated 7Q2 is greater than 1.0 for 13 of the 25 stations (table 5), ranging from 1.1 at Little River at Cameron to 30 at Brazos River near South Bend, indicating an increase in the 7Q2 after regulation. There is no significant difference (table 4) between the annual minimum 7-day discharges for 5 of these 13 stations. The ratios for 2 of these 5 stations with no significant differences (table 4) are about 1.0 (1.1 and 1.2) and the ratios for the remaining 3 stations are substantially greater than 1.0, ranging from 6.4 to 9.5.

The ratios for three stations are less than 1.0, ranging from 0.06 at San Gabriel River at Laneport to 0.65 at Leon River near Belton and indicating a decrease in the 7Q2 after regulation. There is a significant difference (table 4) between the annual minimum 7-day discharges for 1 of the 3 stations (San Gabriel River at Laneport) with the 7Q2 less than 1.0.

The ratio is undefined for 9 stations because the unregulated 7Q2 is zero, but the 7Q2 actually increases after regulation for 6 stations; the remaining 3 stations showed no change (7Q2 = 0). There is a significant difference (table 4) between the annual minimum 7-day discharges for the six stations with an undefined ratio of regulated to unregulated 7Q2. There is no significant difference (table 4) between the annual minimum 7-day discharges for 2 of the 3 stations (Clear Fork Brazos River at Fort Griffin and Aquilla Creek near Aquilla); both have a 7Q2 of zero before and after regulation.

The 7Q2 increased during regulation for 19 of the 25 stations with at least 10 years each of unregulated and regulated discharge data (table 5). Based on the Wilcoxon rank-sum test (table 4), the 7Q2 increased for 14 of the 16 stations with a significant difference at the 95-percent confidence level between unregulated and regulated annual minimum 7-day discharges. The effect of regulation for most stations generally was an increase in the magnitude of the 7Q2.

SUMMARY

The minimum 7-day, 2-year discharge (7Q2) is a useful statistic for assessing the effect that proposed or existing withdrawals or return flows might have on the streamflow and water quality of receiving streams. The contributing drainage area of the Brazos River Basin is more than 35,000 mi^2. Of about 140 streamflow-gaging stations that have been operated in the Brazos River Basin, 97 have at least 10 years of unregulated or 10 years of regulated discharge data. Forty-six stations have at least 10 years of unregulated discharge data only, 26 stations have at least 10 years of regulated discharge data only, and 25 stations have at least 10 years of unregulated and 10 years of regulated discharge data. Fifteen of the 97 stations are on the mainstem Brazos River, and 41 stations are on 10 major tributaries.

Statistical tests were applied to the annual minimum 7-day discharge data of the streamflow-gaging stations. On the basis of the results of the Mann-Kendall test, there is a significant trend at the 95-percent confidence level for 8 of the 46 stations with unregulated data only, 6 of the 26 stations with regulated data only, and 5 stations for the unregulated period and 10 stations for the regulated period of the 25 stations with both unregulated and regulated data. On the basis of the results of the Wilcoxon rank-sum test, there is a significant difference at the 95-percent confidence level between the unregulated and regulated annual minimum 7-day discharges for 16 of the 25 stations with at least 10 years unregulated and 10 years regulated discharge data.

The 7Q2 is estimated by fitting a probability distribution with a 2-year recurrence interval to the annual minimum 7-day discharges. The 7Q2 was estimated for each station with at least 10 years of unregulated or at least 10 years of regulated discharge data using the Pearson Type III distribution fitted by the L-moment statistics of the annual minimum 7-day discharges. The 7Q2 is zero for 31 of the 46 unregulated-only stations and for 9 of the 26 regulated-only stations. The 7Q2 also is zero for 9 stations before regulation and 3 stations after regulation of the 25 stations with both unregulated and regulated data. For the eight regulated-only stations on the mainstem Brazos River, the 7Q2 ranges from 28 to 631 ft^3/s. For the seven stations with both unregulated and regulated data on the mainstem Brazos River, the 7Q2 ranges from 0 to 568 ft^3/s before regulation and from 0.30 to 670 ft^3/s after regulation. The 7Q2 increased during regulation for 19 of the 25 stations with at least 10 years each of data before and after regulation. On the basis of the results of the Wilcoxon rank-sum test and the ratios of regulated 7Q2 to unregulated 7Q2, the effect of regulation for most stations generally was an increase in the magnitude of the 7Q2.

REFERENCES CITED

Helsel, D.R., and Hirsch, R.M., 1992, Studies in environmental science 49–Statistical methods in water resources: Amsterdam, Elsevier, 522 p.

Hosking, J.R.M., 1990, L-moments—Analysis and estimation of distributions using linear combinations of order statistics: Journal Royal Statistical Society, B, v. 52, no. 1, p. 105–124.

Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood-flow frequency: Reston, Va., U.S. Geological Survey, Office of Water Data Coordination, Hydrology Subcommittee, Bulletin 17B [variously paged].

Riggio, R.F., Bomar, G.W., and Larkin, T.J., 1987, Texas drought—Its recent history (1931–1985): Texas Water Commission, LP87–04, 74 p.

Stedinger, J.R., Vogel, R.M., and Foufoula-Georgiou, E., 1993, Frequency analysis of extreme events, *in* Maidment, D.A., ed., Handbook of applied hydrology: New York, McGraw-Hill, chap. 18.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1990, Climatological data, annual summary, Texas, 1990: Asheville, N.C., v. 95, no. 13, 77 p.

Table 1. Reservoirs with normal storage capacities exceeding 5,000 acre-feet, Brazos River Basin, Texas

[mi^2, square miles; acre-ft, acre-feet; --, no U.S. Geological Survey station; NA, contributing drainage area not available]

Station no.	Reservoir	County	Latitude	Longitude	Contributing drainage area (mi^2)	Stream regulated by reservoir	Normal storage capacity (acre-ft)	Year regulation began
08080910	White River Lake	Crosby	33°27'28"	101°05'01"	689	White River	44,897	1964
--	Lake Davis	Knox	--	--	NA	Dutchman Creek	5,395	1959
08082800	Millers Creek Reservoir	Baylor	33°24'32"	99°23'19"	240	Millers Creek	38,800	1974
08083200	Lake Sweetwater	Nolan	33°26'20"	100°18'25"	104	Bitter Creek	2,544	1930
--	Lake Abilene	Taylor	--	--	102	Elm Creek	45,000	1921
--	Lake Kirby	Taylor	--	--	44	Cedar Creek	7,620	1928
08083500	Fort Phantom Hill Lake	Jones	32°36'58"	99°40'05"	470	Big Elm Creek	73,960	1938
08084500	Lake Stamford	Haskell	33°04'44"	99°34'52"	368	Paint Creek	57,927	1953
--	Lake Cisco	Eastland	--	--	NA	Sandy Creek	45,000	1923
--	Lake Daniel	Stephens	--	--	115	Gonzales Creek	11,400	1948
08086400	Hubbard Creek Reservoir	Stephens	32°49'53"	98°58'03"	1,085	Hubbard Creek	318,000	1962
08088400	Lake Graham	Young	33°08'04"	98°36'48"	221	Salt Creek	39,000	1958
08088500	Possum Kingdom Lake	Palo Pinto	32°52'20"	98°25'32"	14,030	Brazos River	724,700	1941
08090300	Lake Palo Pinto	Palo Pinto	32°38'51"	98°16'08"	461	Palo Pinto Creek	44,100	1964
--	Lake Mineral Wells	Parker	--	--	63	Rock Creek	7,065	1920
08090900	Lake Granbury	Hood	32°22'27"	97°41'20"	16,113	Brazos River	153,485	1969
08091730	Squaw Creek Reservoir	Somervell	31°34'46"	97°11'51"	64	Squaw Creek	151,047	1977
08091900	Lake Pat Cleburne	Johnson	31°17'20"	97°24'54"	100	Nolan River	25,600	1964
08092500	Lake Whitney	Bosque	31°51'55"	97°22'18"	17,623	Brazos River	627,100	1951
08093350	Aquilla Lake	Bosque	31°48'44"	97°17'51"	255	Aquilla Creek	52,400	1983

Table 1. Reservoirs with normal storage capacities exceeding 5,000 acre-feet, Brazos River Basin, Texas—Continued

Station no.	Reservoir	County	Latitude	Longitude	Contributing drainage area (mi^2)	Stream regulated by reservoir	Normal storage capacity (acre-ft)	Year regulation began
08095550	Waco Lake	McLennan	31°34'46"	97°11'51"	1,652	Bosque River	152,500	1965
--	Lake Creek Lake	McLennan	--	--	NA	Manos Creek	8,500	1953
--	Tradinghouse Creek Reservoir	McLennan	--	--	39	Tradinghouse Creek	37,814	1968
08099000	Lake Leon	Eastland	32°21'46"	98°40'32"	259	Leon River	27,290	1954
08099400	Proctor Lake	Comanche	31°58'07"	98°29'09"	1,259	Leon River	59,400	1963
08102000	Belton Lake	Bell	31°06'22"	97°28'28"	3,531	Leon River	457,600	1954
08104050	Stillhouse Hollow Lake	Bell	31°01'20"	97°31'57"	1,313	Lampasas River	235,700	1968
08104650	Lake Georgetown	Williamson	30°40'03"	97°43'38"	247	North Fork San Gabriel River	37,100	1980
08105600	Granger Lake	Williamson	30°41'34"	97°19'34"	730	San Gabriel River	65,500	1980
--	Bryan Utilities Lake	Brazos	--	--	NA	Peach Creek	15,227	1975
--	Alcoa Lake	Milam	--	--	NA	Sandy Creek	15,650	1952
08109900	Somerville Lake	Burleson	--	--	1,007	Yegua Creek	160,100	1967
08110300	Lake Mexia	Limestone	31°38'37"	96°34'43"	196	Navasota River	10,000	1962
08110470	Lake Limestone	Robertson	31°19'30"	96°19'08"	675	Navasota River	225,400	1978
--	Twin Oaks Reservoir	Robertson	--	--	NA	Duck Creek	30,319	1982
--	Camp Creek Lake	Robertson	--	--	40	Camp Creek	8,400	1949
--	Gibbons Creek Reservoir	Grimes	--	--	85	Gibbons Creek	32,084	1981
--	William Harris Reservoir	Fort Bend	--	--	NA	Oyster Creek	5,000	1947
--	Smithers Lake	Fort Bend	--	--	24	Dry Creek	18,750	1957

Table 2. Streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data, Brazos River Basin, Texas

[mi^2, square miles; --, no regulated period of record]

Station no.	Station name	County	Latitude	Longitude	Contributing drainage area (mi^2)	Total record (water years)		Regulated record (water years)		Major regulating reservoirs	Areal extent of regulation (percent)
						Period	No.	Period	No.		
08079500	North Fork Double Mountain Fork Brazos River at Lubbock, Texas	Lubbock	33°35'08"	101°49'40"	200	1940–49	10	--	0	--	--
08079575	North Fork Double Mountain Fork Brazos River near Post, Texas	Garza	33°14'52"	101°20'24"	438	1984–93	10	--	0	--	--
08079600	Double Mountain Fork Brazos River at Justiceburg, Texas	Garza	33°02'18"	101°11'50"	244	1962–95	33	--	0	--	--
08080500	Double Mountain Fork Brazos River near Aspermont, Texas	Stonewall	33°00'29"	100°10'49"	1,864	1925–95	66	--	0	--	--
08080540	McDonald Creek near Post, Texas	Garza	33°21'03"	101°13'36"	79.2	1966–78	13	--	0	--	--
08080700	Running Water Draw at Plainview, Texas	Hale	34°10'44"	101°42'08"	382	1940–78	34	--	0	--	--
08080950	Duck Creek near Girard, Texas	Kent	33°21'22"	100°42'17"	279	1965–89	25	1967–89	23	12 flood-retarding structures	25.1
08081000	Salt Fork Brazos River near Peacock, Texas	Stonewall	33°12'43"	100°25'53"	1,985	1964–86	23	1964–86	23	White River Lake	34.7
08081200	Croton Creek near Jayton, Texas	Stonewall	33°17'18"	100°25'52"	290	1960–86	27	--	0	--	--
08081500	Salt Croton Creek near Aspermont, Texas	King	33°24'03"	100°24'29"	64.3	1957–77	21	--	0	--	--
08082000	Salt Fork Brazos River near Aspermont, Texas	Stonewall	33°20'02"	100°14'16"	2,496	1940–95	56	1964–95	32	White River Lake	27.6
08082100	Stinking Creek near Aspermont, Texas	Stonewall	33°14'00"	100°12'47"	88.8	1966–83	18	--	0	--	--
08082180	North Croton Creek near Knox City, Texas	Stonewall	33°22'59"	100°04'51"	251	1966–86	21	--	0	--	--
08082500	Brazos River at Seymour, Texas	Baylor	33°34'51"	99°16'02"	5,972	1925–95	71	1964–95	32	White River Lake	11.5
08082700	Millers Creek near Munday, Texas	Throckmorton	33°19'45"	99°27'53"	104	1964–95	32	--	0	--	--
08083100	Clear Fork Brazos River near Roby, Texas	Fisher	32°47'15"	100°23'18"	228	1963–93	31	--	0	--	--
08083240	Clear Fork Brazos River at Hawley, Texas	Jones	32°35'53"	99°48'53"	1,416	1968–89	22	--	0	--	--
08083245	Mulberry Creek near Hawley, Texas	Jones	32°34'04"	99°47'32"	205	1969–89	21	--	0	--	--
08083300	Elm Creek near Abilene, Texas	Taylor	32°21'08"	99°48'27"	133	1964–79	16	1964–79	16	Lake Abilene	76.7
08083400	Little Elm Creek near Abilene, Texas	Taylor	32°23'29"	99°51'08"	39.1	1964–79	16	--	0	--	--
08084000	Clear Fork Brazos River at Nugent, Texas	Jones	32°41'24"	99°40'09"	2,199	1925–95	71	1938–95	58	Fort Phantom Hill Lake	21.4
08084800	California Creek near Stamford, Texas	Jones	32°55'51"	99°38'32"	478	1963–95	33	--	0	--	--
08085500	Clear Fork Brazos River at Fort Griffin, Texas	Shackelford	32°56'04"	99°13'27"	3,988	1925–95	71	1938–95	58	Fort Phantom Hill Lake	11.8
08086050	Deep Creek at Moran, Texas	Shackelford	32°33'33"	99°10'11"	228	1964–75	12	--	0	--	--

Table 2. Streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data, Brazos River Basin, Texas—Continued

Station no.	Station name	County	Latitude	Longitude	Contributing drainage area (mi^2)	Total record (water years)		Regulated record (water years)		Major regulating reservoirs	Areal extent of regulation (percent)
						Period	No.	Period	No.		
08086100	Hubbard Creek near Albany, Texas	Shackelford	32°41'21"	99°09'52"	454	1963–75	13	--	0	--	--
08086150	North Fork Hubbard Creek near Albany, Texas	Shackelford	32°42'27"	99°16'29"	39.3	1964–90	27	--	0	--	--
08086212	Hubbard Creek below Albany, Texas	Shackelford	32°43'58"	99°08'25"	613	1967–95	29	--	0	--	--
08086290	Big Sandy Creek above Breckenridge, Texas	Stephens	32°38'54"	99°00'15"	280	1963–95	33	--	0	--	--
08086500	Hubbard Creek near Breckenridge, Texas	Stephens	32°50'13"	98°56'52"	1,089	1956–86	31	1962–86	25	Hubbard Creek Reservoir	99.6
08087300	Clear Fork Brazos River at Eliasville, Texas	Young	32°57'36"	98°45'59"	5,697	1918–82	46	1962–82	21	Hubbard Creek Reservoir	19.0
08088000	Brazos River near South Bend, Texas	Young	33°01'27"	98°38'37"	13,107	1939–95	57	1962–95	34	Lake Stamford, Hubbard Creek Reservoir	11.1
08088100	Salt Creek at Olney, Texas	Young	33°22'13"	98°44'40"	11.8	1959–77	19	--	0	--	--
08088300	Briar Creek near Graham, Texas	Young	33°12'43"	98°37'06"	24.2	1959–89	31	--	0	--	--
08088450	Big Cedar Creek near Ivan, Texas	Stephens	32°49'39"	98°43'25"	97	1966–89	24	--	0	--	--
08089000	Brazos River near Palo Pinto, Texas	Palo Pinto	32°51'45"	98°18'08"	14,245	1925–95	71	1941–95	55	Possum Kingdom Lake	98.5
08090500	Palo Pinto Creek near Santo, Texas	Palo Pinto	32°37'51"	98°10'50"	573	1952–76	25	1964–76	13	Lake Palo Pinto	80.5
08090800	Brazos River near Dennis, Texas	Parker	32°36'56"	97°55'32"	15,671	1969–95	27	1969–95	27	Possum Kingdom Lake	89.5
08091000	Brazos River near Glen Rose, Texas	Somervell	32°16'18"	97°39'48"	16,252	1924–95	72	1941–95	55	Possum Kingdom Lake, Lake Granbury	86.3 99.1
08091500	Paluxy River at Glen Rose, Texas	Somervell	32°13'53"	97°46'37"	410	1948–95	48	1983–95	13	14 flood-retarding structures	22.1
08091750	Squaw Creek near Glen Rose, Texas	Somervell	32°16'12"	97°43'56"	70.3	1978–95	18	1978–95	18	Squaw Creek Reservoir	91.0
08092000	Nolan River at Blum, Texas	Hill	32°09'02"	97°24'09"	282	1949–95	43	1964–95	28	Lake Pat Cleburne	35.5
08093100	Brazos River near Aquilla, Texas	Bosque	31°48'44"	97°17'51"	17,678	1939–95	57	1941–95	55	Possum Kingdom Lake, Lake Whitney	79.4 99.7
08093250	Hackberry Creek at Hillsboro, Texas	Hill	32°00'20"	97°08'59"	57.9	1980–92	13	--	0	--	--
08093400	Cobb Creek near Abbott, Texas	Hill	31°55'11"	97°05'57"	12.4	1968–79	12	--	0	--	--
08093500	Aquilla Creek near Aquilla, Texas	Hill	31°50'40"	97°12'04"	308	1940–95	56	1983–95	13	Aquilla Lake	82.8
08093700	North Bosque River at Stephenville, Texas	Erath	32°12'56"	98°11'55"	95.9	1959–79	21	1968–79	12	14 flood-retarding structures	62.4
08094500	Green Creek near Alexander, Texas	Erath	32°04'26"	98°13'46"	45.4	1959–73	15	1959–73	15	8 flood-retarding structures	49.1
08094800	North Bosque River at Hico, Texas	Hamilton	31°58'41"	98°02'04"	359	1963–95	33	1968–95	28	40 flood-retarding structures	56.3
08095000	North Bosque River near Clifton, Texas	Bosque	31°47'09"	97°34'04"	968	1924–95	72	1968–95	28	40 flood-retarding structures	20.9
08095200	North Bosque River at Valley Mills, Texas	Bosque	31°40'10"	97°28'09"	1,146	1960–95	36	1968–95	28	42 flood-retarding structures	18.1

Table 2. Streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data, Brazos River Basin, Texas—Continued

Station no.	Station name	County	Latitude	Longitude	Contributing drainage area (mi^2)	Total record (water years)		Regulated record (water years)		Major regulating reservoirs	Areal extent of regulation (percent)
						Period	No.	Period	No.		
08095300	Middle Bosque River near McGregor, Texas	McLennan	31°30'33"	97°21'56"	182	1960–85	26	--	0	--	--
08095400	Hog Creek near Crawford, Texas	McLennan	31°33'20"	97°21'22"	78.2	1960–85	26	1980–85	6	2 flood-retarding structures	53.7
08095600	Bosque River near Waco, Texas	McLennan	31°36'04"	97°11'36"	1,656	1960–81	22	1965–81	17	Waco Lake	99.8
08096500	Brazos River at Waco, Texas	McLennan	31°32'06"	97°04'22"	20,007	1899–1995	97	1941–95	55	Possum Kingdom Lake, Lake Whitney	70.1 88.1
08097000	Cow Bayou at Mooreville, Texas	Falls	31°18'45"	97°08'16"	83.5	1959–75	17	1959–75	17	26 flood-retarding structures	51.1
08097500	Brazos River near Marlin, Texas	Falls	31°17'18"	96°58'10"	20,645	1939–51	13	1941–51	11	Possum Kingdom Lake	68.0
08098290	Brazos River near Highbank, Texas	Falls	31°08'02"	96°49'29"	20,870	1966–95	30	1966–95	30	Possum Kingdom Lake, Lake Whitney	67.2 84.4
08098300	Little Pond Creek near Burlington, Texas	Milam	31°01'35"	96°59'17"	22.2	1963–82	20	--	0	--	--
08099100	Leon River near De Leon, Texas	Comanche	32°10'25"	98°31'58"	479	1961–86	26	1961–86	26	Lake Leon	54.1
08099300	Sabana River near De Leon, Texas	Comanche	32°06'50"	98°36'19"	264	1961–86	26	1980–86	7	Nabors Lake	Unknown
08099500	Leon River near Hasse, Texas	Comanche	31°57'28"	98°27'32"	1,261	1940–91	52	1963–91	29	Proctor Lake	99.8
08100000	Leon River near Hamilton, Texas	Hamilton	31°47'19"	98°07'16"	1,891	1926–95	41	1963–95	33	Proctor Lake	95.3
08100500	Leon River at Gatesville, Texas	Coryell	31°25'58"	97°45'42"	2,342	1951–95	45	1963–95	33	Proctor Lake	53.8
08101000	Cowhouse Creek at Pidcoke, Texas	Coryell	31°17'05"	97°53'05"	455	1951–95	45	--	0	--	--
08102500	Leon River near Belton, Texas	Bell	31°04'12"	97°26'28"	3,542	1924–95	72	1954–95	42	Belton Lake	99.7
08103800	Lampasas River near Kempner, Texas	Lampasas	31°04'54"	98°00'59"	818	1963–95	33	--	0	--	--
08103900	South Fork Rocky Creek near Briggs, Texas	Burnet	30°54'41"	98°02'12"	33.3	1964–95	32	--	0	--	--
08104000	Lampasas River at Youngsport, Texas	Bell	30°57'26"	97°42'30"	1,240	1925–80	56	--	0	--	--
08104100	Lampasas River near Belton, Texas	Bell	31°00'06"	97°29'32"	1,321	1964–89	26	1968–89	22	Stillhouse Hollow Lake	99.4
08104500	Little River near Little River, Texas	Bell	30°57'59"	97°20'45"	5,228	1924–95	38	1963–95	33	Belton Lake	67.5
08104700	North Fork San Gabriel River near Georgetown, Texas	Williamson	30°39'42"	97°42'40"	248	1969–95	27	1980–95	16	Lake Georgetown	99.6
08104900	South Fork San Gabriel River at Georgetown, Texas	Williamson	30°37'32"	97°41'27"	133	1969–95	27	--	0	--	--
08105000	San Gabriel River at Georgetown, Texas	Williamson	30°39°14"	97°39'18"	405	1935–73	39	--	0	--	--
08105100	Berry Creek near Georgetown, Texas	Williamson	30°41'28"	97°39'21"	83.1	1968–95	28	--	0	--	--
08105300	San Gabriel River near Weir, Texas	Williamson	30°38'45"	97°35'06"	563	1980–90	11	1980–90	11	Lake Georgetown	43.9

Table 2. Streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data, Brazos River Basin, Texas—Continued

Station no.	Station name	County	Latitude	Longitude	Contributing drainage area (mi^2)	Total record (water years)		Regulated record (water years)		Major regulating reservoirs	Areal extent of regulation (percent)
						Period	No.	Period	No.		
08105400	San Gabriel River near Circleville, Texas	Williamson	30°37'43"	97°28'23"	599	1925–76	19	--	0	--	--
08105700	San Gabriel River at Laneport, Texas	Williamson	30°41'39"	97°16'43"	738	1966–95	30	1980–95	16	Granger Lake	98.9
08106500	Little River at Cameron, Texas	Milam	30°49'53"	96°57'01"	7,065	1918–95	78	1954–95	42	Belton Lake	50.0
08108200	North Elm Creek near Cameron, Texas	Milam	30°55'52"	97°01'13"	44.8	1963–73	11	--	0	--	--
08109000	Brazos River near Bryan, Texas	Brazos	30°36'52"	96°29'10"	29,949	1900–92	76	1941–92	52	Possum Kingdom Lake, Lake Whitney	46.8 58.8
08109700	Middle Yegua Creek near Dime Box, Texas	Lee	30°20'21"	96°54'16"	236	1963–95	33	--	0	--	--
08109800	East Yegua Creek near Dime Box, Texas	Burleson	30°24'26"	96°49'02"	244	1963–95	33	--	0	--	--
08110000	Yegua Creek near Somerville, Texas	Burleson	30°19'18"	96°30'26"	1,009	1925–91	67	1967–91	25	Somerville Lake	99.8
08110100	Davidson Creek near Lyons, Texas	Burleson	30°25'10"	96°32'24"	195	1963–95	33	--	0	--	--
08110200	Brazos River at Washington, Texas	Washington	30°21'40"	96°09'18"	31,626	1967–83	17	1967–83	17	Possum Kingdom Lake, Lake Whitney	44.4 55.7
08110325	Navasota River above Groesbeck, Texas	Limestone	31°34'27"	96°31'14"	239	1980–95	16	1980–95	16	Lake Mexia	82.0
08110400	Navasota River near Groesbeck, Texas	Limestone	31°30'44"	96°27'01"	311	1966–78	13	1966–78	13	Lake Mexia	63.0
08110430	Big Creek near Freestone, Texas	Limestone	31°30'25"	96°19'31"	97.2	1979–95	17	--	0	--	--
08110500	Navasota River near Easterly, Texas	Robertson	31°10'12"	96°17'51"	968	1925–95	71	1962–95	34	Lake Mexia, Lake Limestone	20.2 69.7
08111000	Navasota River near Bryan, Texas	Brazos	30°52'10"	96°11'32"	1,454	1952–94	43	1962–94	33	Lake Mexia, Lake Limestone	13.5 46.4
08111500	Brazos River near Hempstead, Texas	Washington	30°07'44"	96°11'15"	34,314	1939–95	57	1941–95	55	Possum Kingdom Lake, Lake Whitney	40.9 51.4
08111700	Mill Creek near Bellville, Texas	Austin	29°52'51"	96°12'18"	376	1964–93	30	--	0	--	--
08114000	Brazos River at Richmond, Texas	Fort Bend	29°34'56"	95°45'27"	35,441	1904–95	75	1941–95	55	Possum Kingdom Lake, Lake Whitney	39.6 49.7
08114500	Brazos River near Juliff, Texas	Fort Bend	29°27'19"	95°31'58"	35,518	1950–69	20	1950–69	20	Possum Kingdom Lake, Lake Whitney	39.5 49.6
08115000	Big Creek near Needville, Texas	Fort Bend	29°28'35"	95°48'45"	42.8	1948–95	45	--	0	--	--
08116400	Dry Creek near Rosenberg, Texas	Fort Bend	29°30'42"	95°44'48"	8.65	1959–79	21	--	0	--	--
08116650	Brazos River near Rosharon, Texas	Fort Bend	29°20'58"	95°34'56"	35,773	1968–95	24	1968–95	24	Possum Kingdom Lake, Lake Whitney	39.2 49.3

Table 3. Mann-Kendall test results of annual minimum 7-day discharges for streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data

[Trend is significant if p-value is less than or equal to α. -, all annual minimum 7-day discharges are zero; --, no data available; <, less than]

Station no.	Station name	Unregulated period			Regulated period		
		Trend at α = 0.050	p-value	Kendall's τ	Trend at α = 0.050	p-value	Kendall's τ
08079500	North Fork Double Mountain Fork Brazos River at Lubbock, Texas	NO	-	-	--		
08079575	North Fork Double Mountain Fork Brazos River near Post, Texas	NO	-	-	--		
08079600	Double Mountain Fork Brazos River at Justiceburg, Texas	NO	-	-	--		
08080500	Double Mountain Fork Brazos River near Aspermont, Texas	NO	-	-	--		
08080540	McDonald Creek near Post, Texas	NO	-	-	--		
08080700	Running Water Draw at Plainview, Texas	NO	-	-	--		
08080950	Duck Creek near Girard, Texas	--			NO	0.958	0.012
08081000	Salt Fork Brazos River near Peacock, Texas	--			NO	.446	.059
08081200	Croton Creek near Jayton, Texas	NO	-	-	--		
08081500	Salt Croton Creek near Aspermont, Texas	NO	0.349	0.152	--		
08082000	Salt Fork Brazos River near Aspermont, Texas	YES	.001	.460	NO	.364	.115
08082100	Stinking Creek near Aspermont, Texas	NO	.758	.052	--		
08082180	North Croton Creek near Knox City, Texas	NO	-	-	--		
08082500	Brazos River at Seymour, Texas	NO	.462	.053	NO	.053	.236
08082700	Millers Creek near Munday, Texas	NO	-	-	--		
08083100	Clear Fork Brazos River near Roby, Texas	YES	.003	.383	--		
08083240	Clear Fork Brazos River at Hawley, Texas	NO	.652	-.740	--		
08083245	Mulberry Creek near Hawley, Texas	NO	.632	.043	--		
08083300	Elm Creek near Abilene, Texas	--			NO	.527	.075
08083400	Little Elm Creek near Abilene, Texas	NO	-	-	--		
08084000	Clear Fork Brazos River at Nugent, Texas	NO	.420	-.179	YES	.020	.208
08084800	California Creek near Stamford, Texas	YES	.001	.402	--		
08085500	Clear Fork Brazos River at Fort Griffin, Texas	NO	.153	-.256	YES	<.001	.417
08086050	Deep Creek at Moran, Texas	NO	.452	.121	--		
08086100	Hubbard Creek near Albany, Texas	NO	-	-	--		

Table 3. Mann-Kendall test results of annual minimum 7-day discharges for streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data—Continued

Station no.	Station name	Unregulated period			Regulated period		
		Trend at $\alpha = 0.050$	p-value	Kendall's τ	Trend at $\alpha = 0.050$	p-value	Kendall's τ
08086150	North Fork Hubbard Creek near Albany, Texas	YES	0.016	0.319	--		
08086212	Hubbard Creek below Albany, Texas	NO	.344	.084	--		
08086290	Big Sandy Creek above Breckenridge, Texas	NO	.189	.049	--		
08086500	Hubbard Creek near Breckenridge, Texas	--			NO	0.211	-0.103
08087300	Clear Fork Brazos River at Eliasville, Texas	NO	.243	-.097	NO	.237	.190
08088000	Brazos River near South Bend, Texas	NO	.354	.134	YES	.037	.253
08088100	Salt Creek at Olney, Texas	NO	-	-	--		
08088300	Briar Creek near Graham, Texas	NO	-	-	--		
08088450	Big Cedar Creek near Ivan, Texas	NO	.211	.091	--		
08089000	Brazos River near Palo Pinto, Texas	NO	.343	-.167	NO	.760	.029
08090500	Palo Pinto Creek near Santo, Texas	NO	-	-	NO	.229	.244
08090800	Brazos River near Dennis, Texas	--			YES	.027	.305
08091000	Brazos River near Glen Rose, Texas	NO	.707	-.074	YES	.003	-.274
08091500	Paluxy River at Glen Rose, Texas	NO	.399	-.101	YES	.004	.603
08091750	Squaw Creek near Glen Rose, Texas	--			NO	.705	-.072
08092000	Nolan River at Blum, Texas	NO	.206	.248	NO	.252	.156
08093100	Brazos River near Aquilla, Texas	--			YES	.004	-.268
08093250	Hackberry Creek at Hillsboro, Texas	NO	-	-	--		
08093400	Cobb Creek near Abbott, Texas	NO	-	-	--		
08093500	Aquilla Creek near Aquilla, Texas	NO	.132	.147	YES	.014	.462
08093700	North Bosque River at Stephenville, Texas	--			NO	.148	-.167
08094500	Green Creek near Alexander, Texas	--			NO	-	-
08094800	North Bosque River at Hico, Texas	--			YES	.050	.257
08095000	North Bosque River near Clifton, Texas	NO	.495	.071	YES	.050	.265
08095200	North Bosque River at Valley Mills, Texas	--			NO	.093	.228

Table 3. Mann-Kendall test results of annual minimum 7-day discharges for streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data—Continued

Station no.	Station name	Unregulated period			Regulated period		
		Trend at $\alpha = 0.050$	p-value	Kendall's τ	Trend at $\alpha = 0.050$	p-value	Kendall's τ
08095300	Middle Bosque River near McGregor, Texas	NO	0.875	-0.025	--		
08095400	Hog Creek near Crawford, Texas	NO	.297	-.174	--		
08095600	Bosque River near Waco, Texas	--			NO	0.286	-0.169
08096500	Brazos River at Waco, Texas	NO	.293	-.114	NO	.072	-.168
08097000	Cow Bayou at Mooreville, Texas	--			NO	.117	-.265
08097500	Brazos River near Marlin, Texas	--			NO	.533	.164
08098290	Brazos River near Highbank, Texas	--			NO	.901	-.018
08098300	Little Pond Creek near Burlington, Texas	NO	-	-	--		
08099100	Leon River near De Leon, Texas	--			NO	-	-
08099300	Sabana River near De Leon, Texas	YES	.012	-.327	--		
08099500	Leon River near Hasse, Texas	YES	.045	-.178	NO	.736	-.047
08100000	Leon River near Hamilton, Texas	--			YES	.032	.259
08100500	Leon River at Gatesville, Texas	YES	.003	.667	NO	.258	.140
08101000	Cowhouse Creek at Pidcoke, Texas	NO	.121	.142	--		
08102500	Leon River near Belton, Texas	NO	.572	-.074	NO	.149	.156
08103800	Lampasas River near Kempner, Texas	NO	.292	.131	--		
08103900	South Fork Rocky Creek near Briggs, Texas	NO	.665	-.018	--		
08104000	Lampasas River at Youngsport, Texas	NO	.959	.006	--		
08104100	Lampasas River near Belton, Texas	--			NO	.735	-.056
08104500	Little River near Little River, Texas	--			YES	.046	.246
08104700	North Fork San Gabriel River near Georgetown, Texas	NO	.350	-.236	YES	<.001	.683
08104900	South Fork San Gabriel River at Georgetown, Texas	NO	.661	.063	--		
08105000	San Gabriel River at Georgetown, Texas	NO	.669	.045	--		
08105100	Berry Creek near Georgetown, Texas	NO	.082	-.220	--		
08105300	San Gabriel River near Weir, Texas	--			NO	.876	-.055

Table 3. Mann-Kendall test results of annual minimum 7-day discharges for streamflow-gaging stations with at least 10 years of unregulated or 10 years of regulated discharge data—Continued

Station no.	Station name	Unregulated period			Regulated period		
		Trend at $\alpha = 0.050$	p-value	Kendall's τ	Trend at $\alpha = 0.050$	p-value	Kendall's τ
08105400	San Gabriel River near Circleville, Texas	YES	0.025	0.380	--		
08105700	San Gabriel River at Laneport, Texas	NO	.324	-.209	NO	0.079	0.333
08106500	Little River at Cameron, Texas	NO	.131	-.178	NO	.269	.120
08108200	North Elm Creek near Cameron, Texas	NO	-	-	--		
08109000	Brazos River near Bryan, Texas	NO	.264	-.167	NO	.868	-.017
08109700	Middle Yegua Creek near Dime Box, Texas	NO	.950	-.006	--		
08109800	East Yegua Creek near Dime Box, Texas	YES	.009	.294	--		
08110000	Yegua Creek near Somerville, Texas	YES	.028	-.121	NO	.772	.043
08110100	Davidson Creek near Lyons, Texas	NO	.094	.129	--		
08110200	Brazos River at Washington, Texas	--			NO	.149	-.265
08110325	Navasota River above Groesbeck, Texas	--			NO	.752	-.042
08110400	Navasota River near Groesbeck, Texas	--			NO	.231	.256
08110430	Big Creek near Freestone, Texas	YES	.006	-.397	--		
08110500	Navasota River near Easterly, Texas	NO	.462	.086	YES	.001	.387
08111000	Navasota River near Bryan, Texas	YES	.011	.578	NO	.121	.191
08111500	Brazos River near Hempstead, Texas	--			NO	.055	.178
08111700	Mill Creek near Bellville, Texas	NO	.432	.103	--		
08114000	Brazos River at Richmond, Texas	NO	.064	-.305	YES	.040	.191
08114500	Brazos River near Juliff, Texas	--			YES	.033	.347
08115000	Big Creek near Needville, Texas	YES	<.001	.678	--		
08116400	Dry Creek near Rosenberg, Texas	NO	-	-	--		
08116650	Brazos River near Rosharon, Texas	--			NO	.333	.145

Table 4. Wilcoxon rank-sum test results of annual minimum 7-day discharges for streamflow-gaging stations with at least 10 years each of unregulated and regulated discharge data

[Unregulated and regulated discharges are significantly different if p-value is less than or equal to α. <, less than]

Station no.	Station name	Significant difference at α=0.05	p-value
08082000	Salt Fork Brazos River near Aspermont, Texas	NO	0.102
08082500	Brazos River at Seymour, Texas	YES	<.001
08084000	Clear Fork Brazos River at Nugent, Texas	NO	.371
08085500	Clear Fork Brazos River at Fort Griffin, Texas	NO	.443
08087300	Clear Fork Brazos River at Eliasville, Texas	YES	<.001
08088000	Brazos River near South Bend, Texas	YES	<.001
08089000	Brazos River near Palo Pinto, Texas	YES	<.001
08090500	Palo Pinto Creek near Santo, Texas	YES	.010
08091000	Brazos River near Glen Rose, Texas	YES	<.001
08091500	Paluxy River at Glen Rose, Texas	NO	.350
08092000	Nolan River at Blum, Texas	YES	.024
08093500	Aquilla Creek near Aquilla, Texas	NO	.551
08095000	North Bosque River near Clifton, Texas	YES	.001
08096500	Brazos River at Waco, Texas	YES	<.001
08099500	Leon River near Hasse, Texas	YES	.001
08100500	Leon River at Gatesville, Texas	YES	.050
08102500	Leon River near Belton, Texas	NO	.329
08104700	North Fork San Gabriel River near Georgetown, Texas	NO	.236
08105700	San Gabriel River at Laneport, Texas	YES	.0112
08106500	Little River at Cameron, Texas	NO	.798
08109000	Brazos River near Bryan, Texas	YES	.002
08110000	Yegua Creek near Somerville, Texas	YES	<.001
08110500	Navasota River near Easterly, Texas	YES	.007
08111000	Navasota River near Bryan, Texas	YES	.016
08114000	Brazos River at Richmond, Texas	NO	.186

Table 5. Estimated minimum 7-day, 2-year discharges for streamflow-gaging stations, Brazos River Basin, Texas

[7Q2, minimum 7-day, 2-year discharge; ft^3/s, cubic feet per second; 7Q, minimum 7-day discharge; --, data not available to compute 7Q2; U, ratio of regulated to unregulated 7Q2 undefined because unregulated 7Q2 is zero; Z, ratio of regulated to unregulated 7Q2 undefined because unregulated and regulated 7Q2 are zero]

Station no.	Station name	Unregulated period			Regulated period			Ratio of regulated to unregulated 7Q2
		7Q2 (ft^3/s)	Annual 7Q		7Q2 (ft^3/s)	Annual 7Q		
			Zero values	Non-zero values		Zero values	Non-zero values	
08079500	North Fork Double Mountain Fork Brazos River at Lubbock, Texas	0	10	0	--			
08079575	North Fork Double Mountain Fork Brazos River near Post, Texas	0	6	4	--			
08079600	Double Mountain Fork Brazos River at Justiceburg, Texas	0	33	0	--			
08080500	Double Mountain Fork Brazos River near Aspermont, Texas	0	47	19	--			
08080540	McDonald Creek near Post, Texas	0	13	0	--			
08080700	Running Water Draw at Plainview, Texas	0	34	0	--			
08080950	Duck Creek near Girard, Texas	--			0.03	2	21	
08081000	Salt Fork Brazos River near Peacock, Texas	--			0	21	2	
08081200	Croton Creek near Jayton, Texas	0	26	1	--			
08081500	Salt Croton Creek near Aspermont, Texas	.25	0	21	--			
08082000	Salt Fork Brazos River near Aspermont, Texas	.08	8	16	.05	0	32	0.62
08082100	Stinking Creek near Aspermont, Texas	0	13	5	--			
08082180	North Croton Creek near Knox City, Texas	.03	7	14	--			
08082500	Brazos River at Seymour, Texas	0	33	6	.30	12	20	U
08082700	Millers Creek near Munday, Texas	0	32	0	--			
08083100	Clear Fork Brazos River near Roby, Texas	.41	2	29	--			
08083240	Clear Fork Brazos River at Hawley, Texas	1.4	0	22	--			
08083245	Mulberry Creek near Hawley, Texas	0	19	2	--			
08083300	Elm Creek near Abilene, Texas	--			0	14	2	
08083400	Little Elm Creek near Abilene, Texas	0	16	0	--			
08084000	Clear Fork Brazos River at Nugent, Texas	.04	4	9	.38	16	42	9.5
08084800	California Creek near Stamford, Texas	.03	5	28	--			
08085500	Clear Fork Brazos River at Fort Griffin, Texas	0	9	4	0	34	24	Z
08086050	Deep Creek at Moran, Texas	0	10	2	--			
08086100	Hubbard Creek near Albany, Texas	0	13	0	--			

Footnote at end of table.

Table 5. Estimated minimum 7-day, 2-year discharges for streamflow-gaging stations, Brazos River Basin, Texas—Continued

Station no.	Station name	Unregulated period			Regulated period			Ratio of regulated to unregulated 7Q2
		7Q2 (ft^3/s)	Annual 7Q		7Q2 (ft^3/s)	Annual 7Q		
			Zero values	Non-zero values		Zero values	Non-zero values	
08086150	North Fork Hubbard Creek near Albany, Texas	0.03	11	16	--			
08086212	Hubbard Creek below Albany, Texas	0	24	5	--			
08086290	Big Sandy Creek above Breckenridge, Texas	0	32	1	--			
08086500	Hubbard Creek near Breckenridge, Texas	--			0	22	3	
08087300	Clear Fork Brazos River at Eliasville, Texas	0	22	3	.12	3	18	U
08088000	Brazos River near South Bend, Texas	.33	11	12	10	2	32	30
08088100	Salt Creek at Olney, Texas	0	19	0	--			
08088300	Briar Creek near Graham, Texas	0	31	0	--			
08088450	Big Cedar Creek near Ivan, Texas	0	22	2	--			
08089000	Brazos River near Palo Pinto, Texas	0	9	7	24	0	55	U
08090500	Palo Pinto Creek near Santo, Texas	0	12	0	0	7	6	Z
08090800	Brazos River near Dennis, Texas	--			33	0	27	
08091000	Brazos River near Glen Rose, Texas	3.1	5	12	[1]13	0	27	4.2
08091500	Paluxy River at Glen Rose, Texas	.44	8	27	2.8	4	9	6.4
08091750	Squaw Creek near Glen Rose, Texas	--			2.2	0	18	
08092000	Nolan River at Blum, Texas	.37	5	10	1.2	2	26	3.2
08093100	Brazos River near Aquilla, Texas	--			[1]28	0	27	
08093250	Hackberry Creek at Hillsboro, Texas	0	13	0	--			
08093400	Cobb Creek near Abbott, Texas	0	12	0	--			
08093500	Aquilla Creek near Aquilla, Texas	0	23	20	0	8	5	Z
08093700	North Bosque River at Stephenville, Texas	--			0	11	1	
08094500	Green Creek near Alexander, Texas	--			0	15	0	
08094800	North Bosque River at Hico, Texas	--			.21	11	17	
08095000	North Bosque River near Clifton, Texas	.68	15	29	3.1	0	28	4.6
08095200	North Bosque River at Valley Mills, Texas	--			7.1	1	27	

Footnote at end of table.

Table 5. Estimated minimum 7-day, 2-year discharges for streamflow-gaging stations, Brazos River Basin, Texas—Continued

Station no.	Station name	Unregulated period			Regulated period			Ratio of regulated to unregulated 7Q2
		7Q2 (ft^3/s)	Annual 7Q		7Q2 (ft^3/s)	Annual 7Q		
			Zero values	Non-zero values		Zero values	Non-zero values	
08095300	Middle Bosque River near McGregor, Texas	0.02	8	18	--			
08095400	Hog Creek near Crawford, Texas	.13	4	16	--			
08095600	Bosque River near Waco, Texas	--			0	11	6	
08096500	Brazos River at Waco, Texas	40	2	40	136	0	55	3.4
08097000	Cow Bayou at Mooreville, Texas	--			0	9	8	
08097500	Brazos River near Marlin, Texas	--			198	0	11	
08098290	Brazos River near Highbank, Texas	--			180	0	30	
08098300	Little Pond Creek near Burlington, Texas	0	20	0	--			
08099100	Leon River near De Leon, Texas	--			0	26	0	
08099300	Sabana River near De Leon, Texas	0	14	5	--			
08099500	Leon River near Hasse, Texas	0	20	3	.75	0	29	U
08100000	Leon River near Hamilton, Texas	--			.25	11	22	
08100500	Leon River at Gatesville, Texas	.33	2	10	1.9	1	32	5.8
08101000	Cowhouse Creek at Pidcoke, Texas	0	27	18	--			
08102500	Leon River near Belton, Texas	3.1	10	20	2.0	6	36	.65
08103800	Lampasas River near Kempner, Texas	9.7	0	33	--			
08103900	South Fork Rocky Creek near Briggs, Texas	0	31	1	--			
08104000	Lampasas River at Youngsport, Texas	5.5	11	45	--			
08104100	Lampasas River near Belton, Texas	--			4.0	0	22	
08104500	Little River near Little River, Texas	--			55	0	33	
08104700	North Fork San Gabriel River near Georgetown, Texas	.16	0	11	1.4	0	16	8.8
08104900	South Fork San Gabriel River at Georgetown, Texas	.08	2	25	--			
08105000	San Gabriel River at Georgetown, Texas	5.3	2	37	--			
08105100	Berry Creek near Georgetown, Texas	0	14	14	--			
08105300	San Gabriel River near Weir, Texas	--			11	0	11	

Footnote at end of table.

Table 5. Estimated minimum 7-day, 2-year discharges for streamflow-gaging stations, Brazos River Basin, Texas—Continued

Station no.	Station name	Unregulated period			Regulated period			Ratio of regulated to unregulated 7Q2
		7Q2 (ft^3/s)	Annual 7Q		7Q2 (ft^3/s)	Annual 7Q		
			Zero values	Non-zero values		Zero values	Non-zero values	
08105400	San Gabriel River near Circleville, Texas	7.0	0	19	--			
08105700	San Gabriel River at Laneport, Texas	17	0	14	1.0	1	15	0.06
08106500	Little River at Cameron, Texas	48	0	36	54	1	41	1.1
08108200	North Elm Creek near Cameron, Texas	0	11	0	--			
08109000	Brazos River near Bryan, Texas	219	0	24	428	0	52	2.0
08109700	Middle Yegua Creek near Dime Box, Texas	0	30	3	--			
08109800	East Yegua Creek near Dime Box, Texas	0	18	15	--			
08110000	Yegua Creek near Somerville, Texas	0	38	4	.02	10	15	U
08110100	Davidson Creek near Lyons, Texas	0	28	5	--			
08110200	Brazos River at Washington, Texas	--			479	0	17	
08110325	Navasota River above Groesbeck, Texas	--			0	14	2	
08110400	Navasota River near Groesbeck, Texas	--			.01	5	8	
08110430	Big Creek near Freestone, Texas	0	12	5	--			
08110500	Navasota River near Easterly, Texas	.70	2	35	1.4	0	34	2.0
08111000	Navasota River near Bryan, Texas	0	6	4	2.2	2	31	U
08111500	Brazos River near Hempstead, Texas	--			631	0	55	
08111700	Mill Creek near Bellville, Texas	2.8	0	30	--			
08114000	Brazos River at Richmond, Texas	568	0	20	670	0	55	1.2
08114500	Brazos River near Juliff, Texas	--			148	5	15	
08115000	Big Creek near Needville, Texas	.27	14	31	--			
08116400	Dry Creek near Rosenberg, Texas	0	21	0	--			
08116650	Brazos River near Rosharon, Texas	--			579	0	24	

[1]7Q2 based on regulated period 1969–95.