Prepared in cooperation with Oklahoma State University and the Oklahoma Water Resources Board

Determination of Baseline Periods of Record for Selected Streamflow-Gaging Stations in and near Oklahoma for use in Modeling Applications

Scientific Investigations Report 2010–5106

U.S. Department of the Interior
U.S. Geological Survey

Cover: The bridge and channel at Skeleton Creek near Lovell (07160500), August 2001. Photograph by Martin L. Schneider, U.S. Geological Survey.

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)

Vertical coordinate information is referenced to the insert datum name (and abbreviation) here for instance, “North American Vertical Datum of 1988 (NAVD 88).”

Horizontal coordinate information is referenced to the insert datum name (and abbreviation) here for instance, “North American Datum of 1983 (NAD 83).”

Altitude, as used in this report, refers to distance above the vertical datum.

Water year is the 12-month period October 1 through September 30, and is named for the year in which it ends.

Determination of Baseline Periods of Record for Selected Streamflow-Gaging Stations in and near Oklahoma for use in Modeling Applications

By Rachel A. Esralew

Abstract

Use of historical streamflow data from a least-altered period of record can be used in calibration of various modeling applications that are used to characterize least-altered flow and predict the effects of proposed streamflow alteration. This information can be used to enhance water-resources planning. A baseline period of record was determined for selected streamflow-gaging stations that can be used as a calibration dataset for modeling applications. The baseline period of record was defined as a period that is least-altered by anthropogenic activity and has sufficient streamflow record length to represent extreme climate variability. Streamflow data from 171 stations in and near Oklahoma with a minimum of 10 complete water years of daily streamflow record through water year 2007 and drainage areas that were less than 2,500 square miles were considered for use in the baseline period analysis.

The first step to determine the least-altered period of record was to evaluate station information by using previous publications, historical station record notes, and information gathered from oral and written communication with hydrographers familiar with selected stations. The second step was to indentify stations that had substantial effects from upstream regulation by evaluating the location and extent of dams in the drainage basin. The third step was (a) the analysis of annual hydrographs and included visual hydrograph analysis for selected stations with 20 or more years of streamflow record, (b) analysis of covariance of double-mass curves, and (c) Kendall's tau trend analysis to detect statistically significant trends in base flow, runoff, total flow, and base-flow index related to anthropogenic activity for selected stations with 15 or more years of streamflow record.

A preliminary least-altered period of record for each stream was identified by removing the period of streamflow record when streams were substantially affected by anthropogenic activity. After streamflow record was removed from designation as a least-altered period, stations that did not have at least 10 years of remaining continuous streamflow record were considered to have an insufficient baseline period for modeling applications.

An optimum minimum period of record was determined for each of the least-altered periods for each station to ensure a sufficient streamflow record length to provide a representative sample of annual climate variability. An optimum minimum period of 10 years or more was evaluated by analyzing the variability of annual precipitation for selected 5-, 10-, 15-, 25-, and 35-year periods for each of 20 climate divisions that contained stations used in the baseline period analysis. The distribution of annual precipitation was compared for each consecutive overlapping 5-year period to the period 1925–2007 by using a Wilcoxon rank-sum test. The least-altered period of record for stations was also compared to the period 1925–2007 by using a Wilcoxon rank-sum test. The results of this analysis were used to determine how many years of annual precipitation data were needed for the selected period to be statistically similar to the distribution of annual precipitation data for a long-term period, 1925–2007. Minimum optimum periods ranged from 10 to 35 years and varied by climate division.

A final baseline period was determined for 111 stations that had a baseline period of at least 10 years of continuous streamflow record after the record-elimination process. A suitable baseline period of record for use in modeling applications could not be identified for 58 of the initial 171 stations because of substantial anthropogenic alteration of the stream or drainage basin and for 2 stations because the least-altered period of record was not representative of annual climate variability. The baseline period for each station was rated "excellent", "good", "fair", "poor", or "no baseline period." This rating was based on a qualitative evaluation of the approximate degree of basin alteration for the least-altered period of record, and whether or not the least-altered period was long enough to be representative of long-term climate variability. Baseline periods of record were rated as "excellent" for 22 stations, "good" for 42 stations, "fair" for 24 stations, and "poor" for 23 stations.

Introduction

Managing rivers and streams to maintain physical, chemical, and biological integrity is a challenge for resource managers in Oklahoma and nationwide. Knowledge of how anthropogenic activity and climate change affect the flow regime can be helpful for water supply regulation and planning. Currently (2010), the Oklahoma 50-Year Comprehensive Water Plan requires development of stream water allocation models to predict how proposed alterations may affect water supply for consumptive and nonconsumptive uses (Robert S. Fabian, Oklahoma Water Resources Board, oral and written commun., July 2008). These models are part of the process for development of a water-permitting policy for Oklahoma.

The use of historical streamflow data from a least-altered period of record can enhance water resources planning. These data can be used to calibrate various modeling applications that are used to characterize unregulated flow and predict the effects of proposed streamflow alteration. Streamflow data commonly are needed from streams that are difficult or cost-prohibitive to gage. Streamflow can be estimated for many ungaged stream locations by using digital watershed or regression models. The following are examples of frequently used digital watershed modeling applications in which verification or calibration by using long-term data from streamflow-gaging stations (referred to as "stations" in this report) are required: Hydrologic Simulation Program-Fortran (HSPF) (Donigan and others, 1984), Spatially Referenced Regresssion on Watershed Attributes (SPARROW) (Preston and others, 2009), Precipitation Runoff Modeling System (PRMS) (Leavesley and others, 1983), MIKE_11 [Havnø and others, 1995], and TOPMODEL [Wolock, 1993]). Regression models often are used to estimate flow statistics at ungaged stream locations (for example, the U.S. Geological Survey, StreamStats program, U.S. Geological Survey, 2009a), and many regression applications require use of a least-altered period of streamflow data (or streamflow record) for model calibration (Esralew and Smith, 2009). A least-altered period of streamflow record was used to create the U.S. Geological Survey (USGS) Hydroecological Integrity Assessment Process for Oklahoma (HIP) (Turton and others, 2009). This model can be used to estimate how proposed flow alteration may affect flow parameters that are vital to aquatic ecological function. For this report, continuous streamflow data from streamflow gaging-stations are referred to as "streamflow record" and a specified period during which continuous daily streamflow data are calculated is referred to as a "period of record".

Ideally, modeling applications that use data from stations to characterize unaltered flow need to include data from a long-term period of record. This period of record should reflect the least-altered condition of streamflow available. Demand for water increases with population, urban, and agricultural development increases, and increasing recreational use. Typical anthropogenic activity that affects streamflow may include streamflow regulation, irrigation, diversion and groundwater withdrawal for industrial and consumptive water supply, effluent discharge, and urban development (Stankowski 1972; Fitzpatrick and others, 1999; Konrad and Booth, 2002; Smith and Wahl, 2003).

The unpredictable nature of current and future patterns in climate also can affect streamflow. Streamflow data have been collected for streams in and near Oklahoma during periods ranging from a few years to nearly a century (USGS National Water Information System, *http://waterdata.usgs.gov/nwis*, accessed November 1, 2007). The least-altered period of record for some stations (referred to in this report as the "least-altered period") may be short because of few streamflow data and an increase in urban or agricultural development of a stream with time. Shorter periods of record may coincide with aberrant climate and streamflow patterns that are not considered typical. Longer periods of record are more likely to provide a representative sample of central tendencies and variability of streamflow. A sufficient streamflow record length (at least 10 years, for example) would likely increase the probability that variability of the daily hydrograph, caused by recurrent climate cycles, is included in the streamflow data used for model calibration. Therefore, longer periods of streamflow record can help to minimize statistical bias and random error in modeling applications.

A baseline period of record (referred to in this report as a "baseline period") may be determined for stations with a sufficient streamflow record. The baseline period can be defined as a period in which streamflow is least-altered by anthropogenic activity and has sufficient streamflow record length to represent annual climate variability. By this definition, some stations cannot be assigned a baseline period because streamflow at these stations is substantially altered or the length of the period of record is short. To address the need for a least-altered period of record for use in modeling applications and water-resources planning, the USGS, in cooperation with Oklahoma State University and the Oklahoma Water Resources Board, conducted a study to determine baseline period of record for selected streamflow-gaging stations in and near Oklahoma.

Streamflow at few if any streams in or near Oklahoma have been completely free of alteration from anthropogenic activity during the last century. Therefore, streamflow record that includes effects from anthropogenic alteration must be included in evaluation of Oklahoma streamflow to obtain a sufficiently long-term period of record representative of streamflow during varied climate. The goal of the baseline period determination process, in Oklahoma, is to select, for each station, a sufficiently long period that is "least-altered." The period of streamflow data, in which the degree of alteration is substantially high, can be eliminated from inclusion in a baseline period. The degree of anthropogenic alteration may vary spatially and temporally. Subjective decisions may be involved in the process to determine if a period is "altered". Examples of such change include increased irrigation during a period of time, continued construction of many small flood retarding structures, or urbanization of a drainage basin.

Substantial streamflow alteration can be caused by a variety of human activities. Consumptive water uses are common throughout Oklahoma, including irrigation, livestock, and public water-supply from surface-water and groundwater sources (Tortorelli, 2009).

Many surface-water sources for water-supply in Oklahoma are from reservoirs or other impoundments (Tortorelli, 2009). Flood-peak reduction also affects streamflow for large areas of Oklahoma, mainly from many floodwater-retarding structures that serve to decrease main-stem flood peaks and regulate the rate of runoff recession (Bergman and Huntzinger, 1981; Tortorelli and Bergman, 1985). Substantial regulation of streamflow from reservoirs and other impoundments can alter the magnitude, frequency, and duration of streamflow, depending on the intended water use and the extent of the regulation. Specifically, regulation can alter the seasonal flow regime, decrease the magnitude and frequency of flooding, increase the duration and frequency of zero-flow and low-flow periods, and decrease long-term average flows downstream (Tortorelli and Bergman, 1985).

Most irrigation water used in Oklahoma comes from groundwater, most of which comes from the High Plains Aquifer in western Oklahoma. Groundwater also is used for municipal public water supply, livestock, and oil and gas development (Tortorelli, 2009). Groundwater withdrawals in the drainage basin of a stream can affect streamflow through reduction of base flow or alteration of base-flow patterns (Wahl and Tortorelli, 1997).

Quality assurance and examination of outliers in modeling applications may require a qualitative assessment of the data used to calibrate the model. A quality ranking can be assigned to each baseline period to reduce the subjectivity of data selection and comparison. For example, terms such as “excellent”,“good”, “fair”, and “poor”, can be assigned to the period of record on the basis of the degree of anthropogenic activity, severity of climatic bias for the period with the least anthropogenic activity, and length of the streamflow record. In this scenario, selection of a baseline period for each stream would be a period with the most favorable quality ranking based on these criteria.

Purpose and Scope

This report describes the process used to determine baseline periods of record for selected stations in and near Oklahoma with more than 10 years of continuous streamflow data. The baseline period determination process included identification of a least-altered period and the minimum number of years to reflect climate variability.

This report documents the methods used to select the least-altered period that include (1) analysis of historical information about stations and basins, (2) assessment of the change in the area upstream from dams in the basins, and (3) visual and statistical trend analysis to determine the year when anthropogenic activity may have altered streamflow. The process used to determine an optimum minimum number of years for a least-altered period to be considered baseline is described. The optimum minimum number of years is based on the minimum time period required to represent annual variability of climate. Also described is the process used to determine a quality ranking for each baseline period. The final baseline period and quality ranking determined for streamflow record at selected stations is presented.

Selection of Data for Analysis

Streamflow data from 171 stations in and near Oklahoma were considered for use in the baseline period analysis (fig. 1). These stations had a minimum of 10 complete water years of daily streamflow record through water year 2007 and a drainage area that was less than 2,500 square miles (fig. 1). Daily mean streamflow data for USGS stations in Oklahoma and adjacent states are available on the World Wide Web (URL *http://waterdata.usgs.gov/ok/nwis/* and *http://waterdata.usgs.gov/us/nwis*). Ten years of continuous streamflow record was assumed to be the minimum required for defining the least-altered period. This assumption was based on the use of a minimum of 10 years of streamflow record for computation of long-term streamflow statistics in Oklahoma (Heimann and Tortorelli, 1988; Tortorelli, 2002; Lewis and Esralew, 2009). Gaps in the continuous streamflow record were accepted as long as the total streamflow record equaled or exceeded 10 complete water years.

Stations selected for baseline period analysis include only those in which the drainage area to that station is completely in 8-digit hydrologic unit (HU) boundaries that are in Oklahoma or touch the Oklahoma state border (fig. 1). These criteria were required because basin-characteristic data were not readily available for stations with drainage basins that extend outside of this area (Smith and Esralew, 2009). Basin characteristic data were used to determine the extent of regulation that was part of the process used to determine the least-altered period (see section titled “Evaluation of Basin Regulation to Eliminate Nonbaseline Years and Refine Preliminary Least-Altered Periods”). Stations selected for the baseline period analysis only included stations in which the drainage area was less than 2,500 square miles. For this report, drainage area sizes greater than 2,500 square miles were considered substantially large, which is the same criteria for drainage-area size defined in a previous study (Tortorelli, 1997). Stations with drainage areas larger than this size are more difficult to analyze for a least-altered period because of the challenge in identification of a potentially large range of anthropogenic activities that may affect streamflow in large basins. Analysis of station records with drainage areas of this size was beyond the scope of this study. Analysis of station records along main stems of the largest river systems in the state (the Arkansas, Canadian, Neosho, Red, and Verdigris Rivers; and lower parts of the Cimarron, North Canadian, and Washita Rivers) was not considered for this report because the drainage areas were greater than 2,500 square miles or extend outside of the study area.

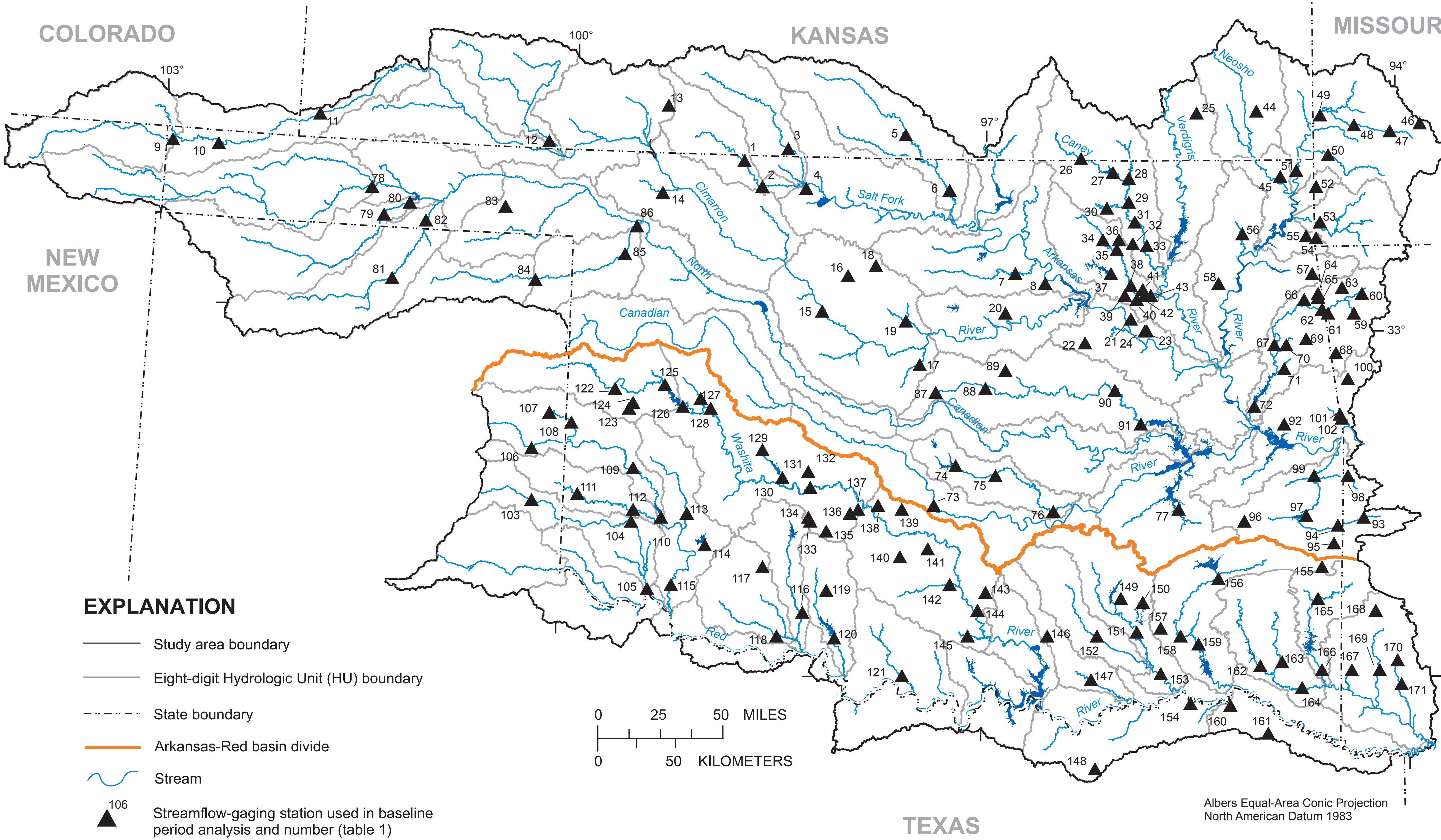

Figure 1. Selected streamflow-gaging stations with 10 or more years of continuous daily streamflow record and a drainage area of less than 2,500 square miles.

Methods Used to Determine the Baseline Period of Record

The process used to determine the baseline period for each station was completed in two phases. An overview of the processes used to determine the baseline period is in figure 2 with notation of the table in which the results are presented.

A least-altered period was determined for each station in the first phase of the analysis. A least-altered period for a station is the continuous period that remained after eliminating years altered by anthropogenic activities. The first phase was divided into three steps each of which was used to determine and evaluate potential anthropogenic alteration that may affect streamflow. First, historical station information was evaluated from previous publications, record notes, and oral and written communication. Second, stations wth streamflows that were substantially affected from upstream dams were identified by determining the location and extent of dams in the drainage basin, and the percentage of the drainage basin upstream from dams. Third, visual and statistical trend analysis was used for selected stations with 20 or more years of continuous streamflow record to detect statistically significant changes in base flow, runoff, total flow, and base-flow index that might be attributable to anthropogenic alteration. During each step, streamflow record from the station in which anthropogenic activity was suspected to alter streamflow was either removed from consideration for the least-altered period or the quality rank that described the least-altered period was adjusted accordingly.

An optimum minimum period of record was determined for stations in each Climate Division (National Oceanic and Atmospheric Administration, 2008) in the second phase of the analysis (fig. 3). Climate divisions are considered regions that are homogeneous with respect to climate and hydrologic conditions (National Oceanic and Atmospheric Administration, 2008). Statistical analysis of annual precipitation data was used to determine whether 10 years of streamflow record sufficiently represented long-term climate variability.

Determination of Least-Altered Period of Record

The methods used to determine the least-altered period are described in this section. These methods comprise the first phase of the process used to determine a baseline period.

Analysis of Historical Station and Basin Information to Eliminate Nonbaseline Years and Define Preliminary Least-Altered Period of Record

Historical basin information was used to eliminate streamflow record during nonbaseline years from selected stations to identify a preliminary least-altered period. Historical information about each station was obtained from previous USGS publications (Heimann and Tortorelli, 1988; Wahl and Tortorelli, 1997; Tortorelli, 2002; Smith and Wahl, 2003; Tortorelli and others, 2005; U.S. Geological Survey, 2008; and Lewis and Esralew, 2009), from information provided by hydrographers at the USGS Oklahoma Water Science Center, and from information gathered from historical station records filed at the USGS Oklahoma Water Science Center (table 1, back of report).

Annual reports (U.S. Geological Survey, 2008) and hydrographer records typically included comments about suspected anthropogenic activities that might affect the streamflow. These activities included information about regulation, diversion, irrigation, and sewage effluent discharge. Groundwater withdrawals in the drainage basin were difficult to document because of scarce historical groundwater-use data availability in Oklahoma (Robert L. Tortorelli, U.S. Geological Survey, oral commun., August 2008). In addition, some comments were subjective because of the inconsistency with which a hydrographer might choose to document observations pertaining to human activities in the basin. A preliminary least-altered period was determined for each station on the basis of evaluation of all available historical information.

If substantial anthropogenic activity began from a known date during the period of record, then the period before that date was considered for the preliminary least-altered period. For example, authors of previous publications consider a basin to be substantially regulated if 20 percent or more was affected by regulation (Heimann and Tortorelli, 1988, Tortorelli 2002; Lewis and Esralew, 2009). This criterion was used to eliminate nonbaseline years from the period of record that could not be considered least-altered or eliminate stations that did not have a least-altered period suitable for a baseline period. If less than 10 years of streamflow record for a given station were not substantially affected by anthropogenic activity, then all data from the station was eliminated from consideration as a baseline period. Quality rankings were assigned for each preliminary least-altered period on the basis of professional judgment.

The methods for this step are limited to use of available historical information in record notes. Examples of anthropogenic activities in Oklahoma that may affect streamflow but may not have been documented in the historical record include regional irrigation and other agricultural activities (Tortorelli, 2009), water-use for shale-gas well hydraulic fracturing (Schein, 2008), and clear-cutting from logging operations in southeastern Oklahoma (Howell and Johnson, 2003). Although water-use assessments for Oklahoma were reported in previous studies by 4-digit HU, by major aquifer, and on a statewide basis (Tortorelli, 2009), historical water-use estimates are not well documented at the drainage-basin level. Incorporation of this information into the least-altered period determination process was beyond the scope of this report; however, further investigation into historical water-use at the drainage-basin level may be useful for refinement of the least-altered period of record.

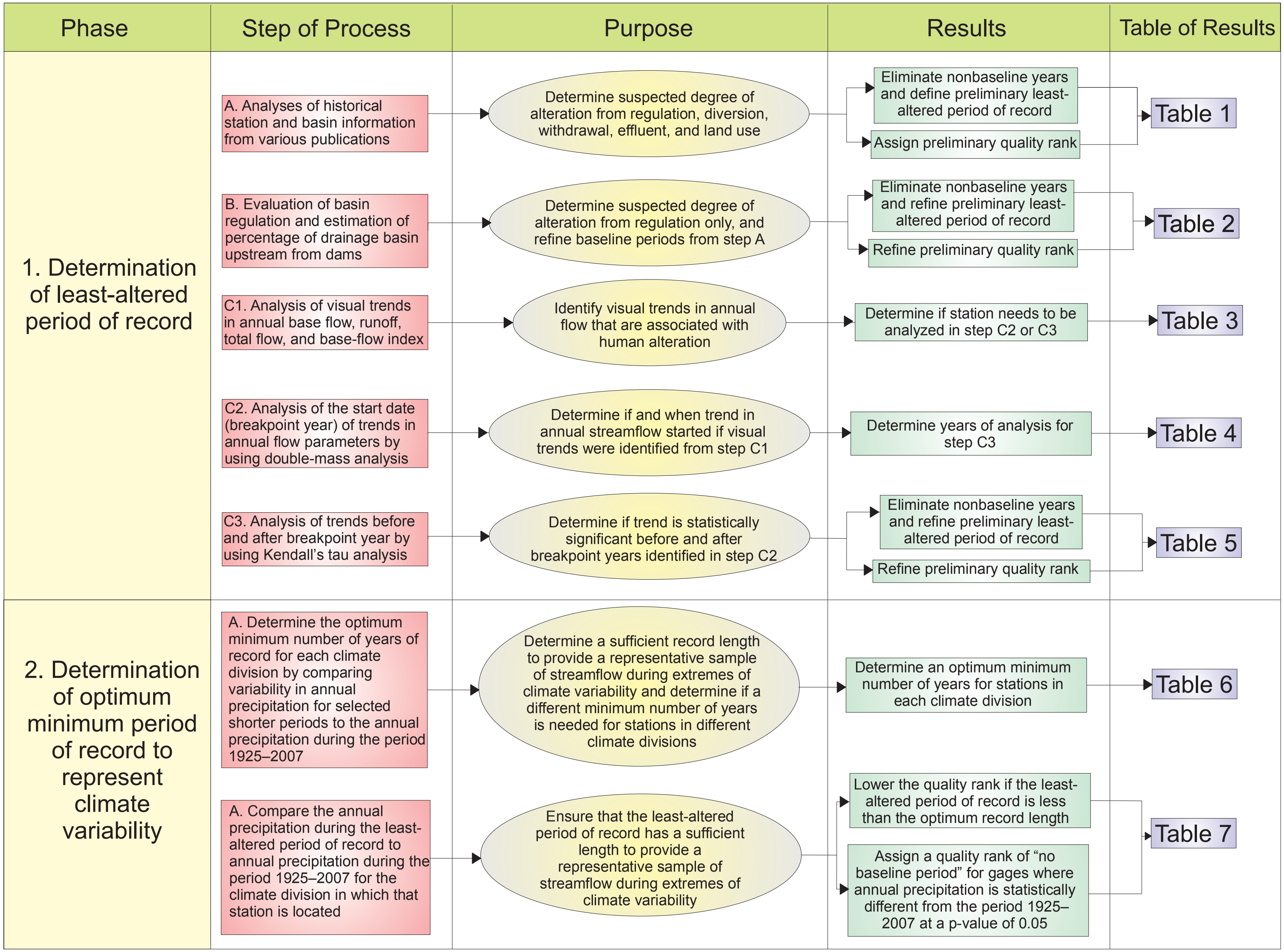

Figure 2. Overview of processes used to determine the baseline period of record for selected streamflow-gaging stations.

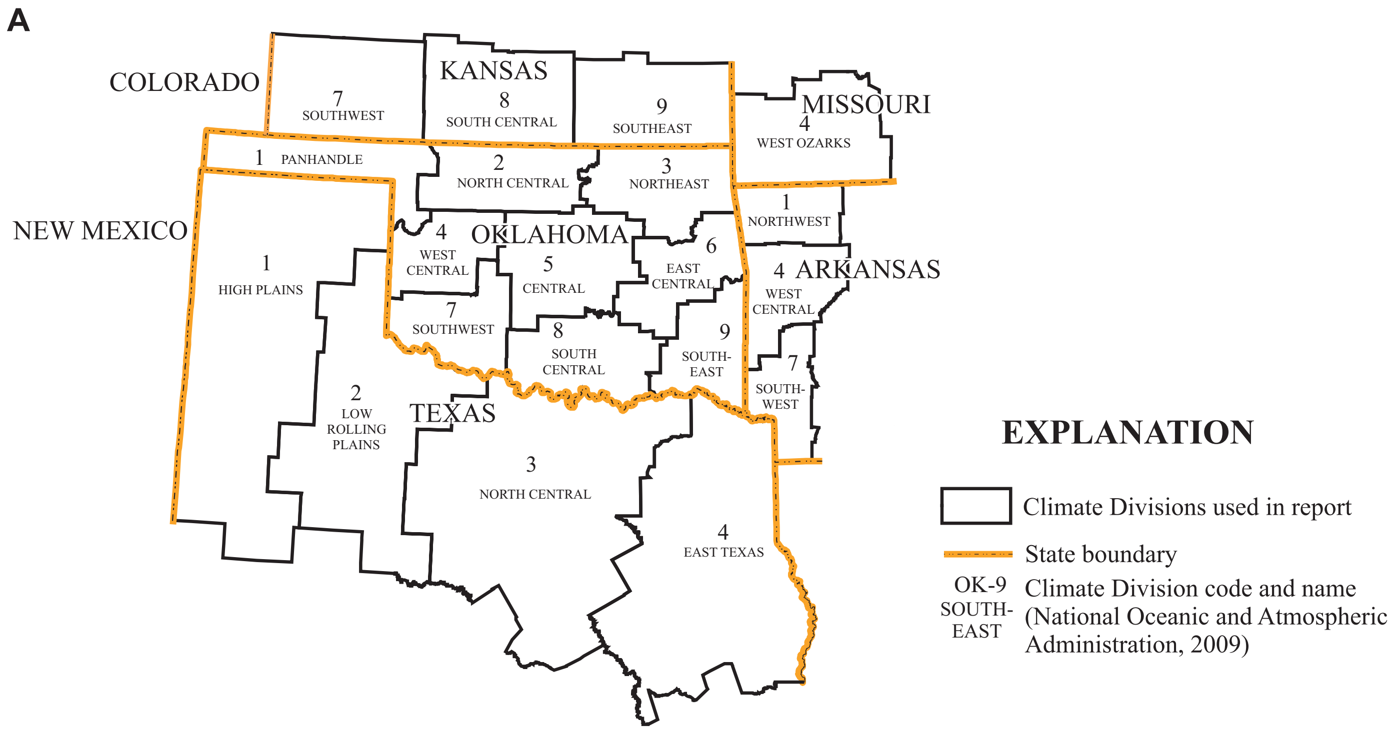

Figure 3. National Weather Service Climate Divisions used in annual precipitation analysis.

Evaluation of Basin Regulation to Eliminate Nonbaseline Years and Refine Preliminary Least-Altered Periods

The purpose of this step was to further evaluate the extent of regulation in the drainage basins for stations that were analyzed in the previous step. Although previous publications identified whether or not streamflow at a station was regulated by dams affecting 20 percent or more of the drainage basin, (Heimann and Tortorelli, 1988; Tortorelli, 2002; Lewis and Esralew, 2009), or 10 percent or more of the basin (Long and others, 2004), little was documented regarding less extensive (minor) regulation in the basin. Even minor regulation from dams and other impoundments may affect the streamflow regime depending on the rate of withdrawals and management of releases. The extent of regulation, as indicated by the number of dams in the drainage basin, was analyzed for stations that had at least 10 years of least-altered continuous streamflow record as determined from the previous step. For these stations, each drainage basin was delineated by using ArcInfo software (Environmental Systems Research Institute, Incorporated, 2007). The U.S. Army Corps of Engineers National Inventory of Dams (NID) (U.S. Army Corps of Engineers, 2008) and the Oklahoma Water Resources Board Oklahoma Water Atlas (Vance, 2007) were used to locate dams in the drainage basin. Uses for these dams include flood control, public-water supply, hydropower, recreation, and agricultural uses (irrigation supply and farm impoundments). The drainage area upstream from the dams was determined and the percentage of the total drainage area for the station that was affected by dams was calculated. Only dams with certain characteristics were considered in the analysis. Dams were considered in this analysis if the dams had (1) an upstream drainage area of at least 9,700 square feet, (2) were classified as (a) a dam with high or substantial hazard potential, (b) were classified as a dam with a low-hazard potential that exceeds 25 feet in height and 15 acre-feet storage or (c) were classified as a dam with low-hazard potential that exceeds 50 acre-feet storage and is at least 6 feet high, (U.S. Army Corps of Engineers, 2008), and (3) had a documented year of completion. The dam locations were verified by using National Agriculture Imagery Program (NAIP) 2003 or 2006 color aerial photography (U.S. Department of Agriculture, 2008) and U.S. Geological Survey 7.5-minute, 1:24,000 scale topographic map quadrangles (U.S. Geological Survey, 2009b).

Many small farm impoundments are constructed for domestic or small-scale use. The dams that form these impoundments were often difficult to locate, or were not on drainages that met the size requirement for accurate delineation, and were omitted from analysis. Therefore, estimates of area upstream from dams presented in this report most likely underestimate the total drainage area affected by regulation. However, the drainage area upstream from farm impoundments is typically small when compared to the total drainage area upstream from the stations in this report. The farm impoundments in drainage areas of stations that were considered in this analysis (farm impoundments that could be located and met the drainage area requirements for delineation) had drainage-basin areas that ranged from 0.25 acre to 14 square miles, and had an average drainage area of 0.7 square mile. The average drainage area for stations considered for this step was 559 square miles.

The year that a dam was completed was used to construct a time-series plot of drainage area upstream from dams. Nested dams, or dams that are upstream from other dams, were not included in the computation if the year of completion of the nested dam was after that of a dam that was downstream. As an example, figure 3 shows the percentage of the drainage area at Washita River near Clinton (07325000) that was affected by impoundment with time.

The least-altered period was refined from the previous steps by either (1) excluding years in which the drainage areas upstream from dams ranged from 1 percent to 20 percent of the drainage area if at least 10 years of streamflow record remained after the years were excluded, or (2) modification of the quality rank for the least-altered period.

Streamflow record in which more than 20 percent of the drainage area was upstream from dams was removed from consideration for the least-altered period and if less than 10 years remained, then the streamflow record for the station was not considered suitable as a baseline period. Visual inflections in the plots of drainage area upstream from dams with time were used to locate a time period in which increases in the area upstream from dams were visually prominent. This analysis was done for stations that had 10 or more years of streamflow record in which regulation affected less than 20 percent of the drainage area. The year prior to the inflection point was used as the end year for the new least-altered period. If the percentage of the drainage area upstream from dams was gradual with time, an incremental procedure was used. The year prior to the year when 10, 15, or 20 percent of the drainage basin was upstream from dams was selected as the end year for the new least-altered period. A preference was given to lower percentages of drainage area upstream from dams, if the resulting streamflow record length after data elimination was at least 10 years. Drainage basins in which less than 1 percent of the drainage area was upstream from dams were assumed to have no notable regulation and remarks were noted (table 2, back of report). Drainage basins in which less than 5 percent of the drainage area was upstream from dams were considered to have minor regulation. However, the least-altered period was not reduced on the basis of this criteria. Instead, the quality ranking was adjusted. This approach was used to avoid excessive elimination of least-altered years based on a minor amount of regulation.

The preliminary quality ranking was adjusted on the basis of the degree of alteration indicated by historical records and the extent of the drainage area upstream from dams. The remaining period of record was re-assessed to determine if a known alteration from historical information was indicated from the previous step of the analysis. If no known alteration was indicated during the remaining period, the following procedures were used to determine the preliminary quality ranking: (1) if the resulting least-altered period for a station included a period in which 1 to 5 percent of the drainage area was upstream from dams, then the quality rank was changed to “good”, (2) if the drainage area upstream from dams was between 5 and 10 percent it was changed to “fair”, or (3) if the drainage area upstream from dams affected an area greater than 10 percent and less than 20 percent of the drainage basin, the rank was changed to “poor”.

The quality rank was adjusted by using professional judgment for stations in which streamflow record elimination was performed and additional indications of alteration were apparent from historical information. For example, if the remarks from the previous step pertained to regulation (such as diversions for water supply), then the quality rank was not adjusted again. Some periods of streamflow record were eliminated from further consideration because of substantial historical alteration not related to regulation (such as groundwater pumping or sewage effluent).

An example of this procedure is demonstrated for Washita River near Clinton, with a period of record of 1936–2007 (fig. 4). Previous publications and historical information indicate that this station has been regulated by Foss Reservoir since 1961 (Lewis and Esralew, 2009). Prior to 1961, streamflow at the station was regulated by many upstream floodwater-retarding structures that affected less than 20 percent of the drainage area (Heimann and Tortorelli, 1988; Tortorelli, 2002; Lewis and Esralew, 2009), but the extent of this regulation was unavailable in existing documentation. The drainage area consists of more than 1 percent drainage area upstream from dams since 1931, more than 5 percent drainage area upstream from dams since 1952, more than 10 percent drainage area upstream from dams since 1956, and a little less than 20 percent drainage area upstream from dams since 1960 just prior to the construction of Foss Reservoir. The change from 1 percent to less than 20 percent drainage area upstream from dams represents a gradual increase with time. Because at least 10 years of streamflow record were available in which less than 10 percent of the drainage area was upstream from dams, the least-altered period was reduced to the period prior to 1956. As a result, the preliminary least-altered period for this station was 1936–1955, and the quality rank was assigned as “fair”.

Visual Trend Analysis and Double-Mass Analysis of Annual Streamflow to Eliminate Nonbaseline Years and Refine Preliminary Least-Altered Period

Additional analysis of annual streamflow record was used to test whether the qualitative indicators of alteration determined in previous steps had an observable effect on the annual streamflow regime. In order to further eliminate nonbaseline years and better define the least-altered period, a statistical approach was used for selected streams to detect if substantial changes in annual streamflow patterns might be associated

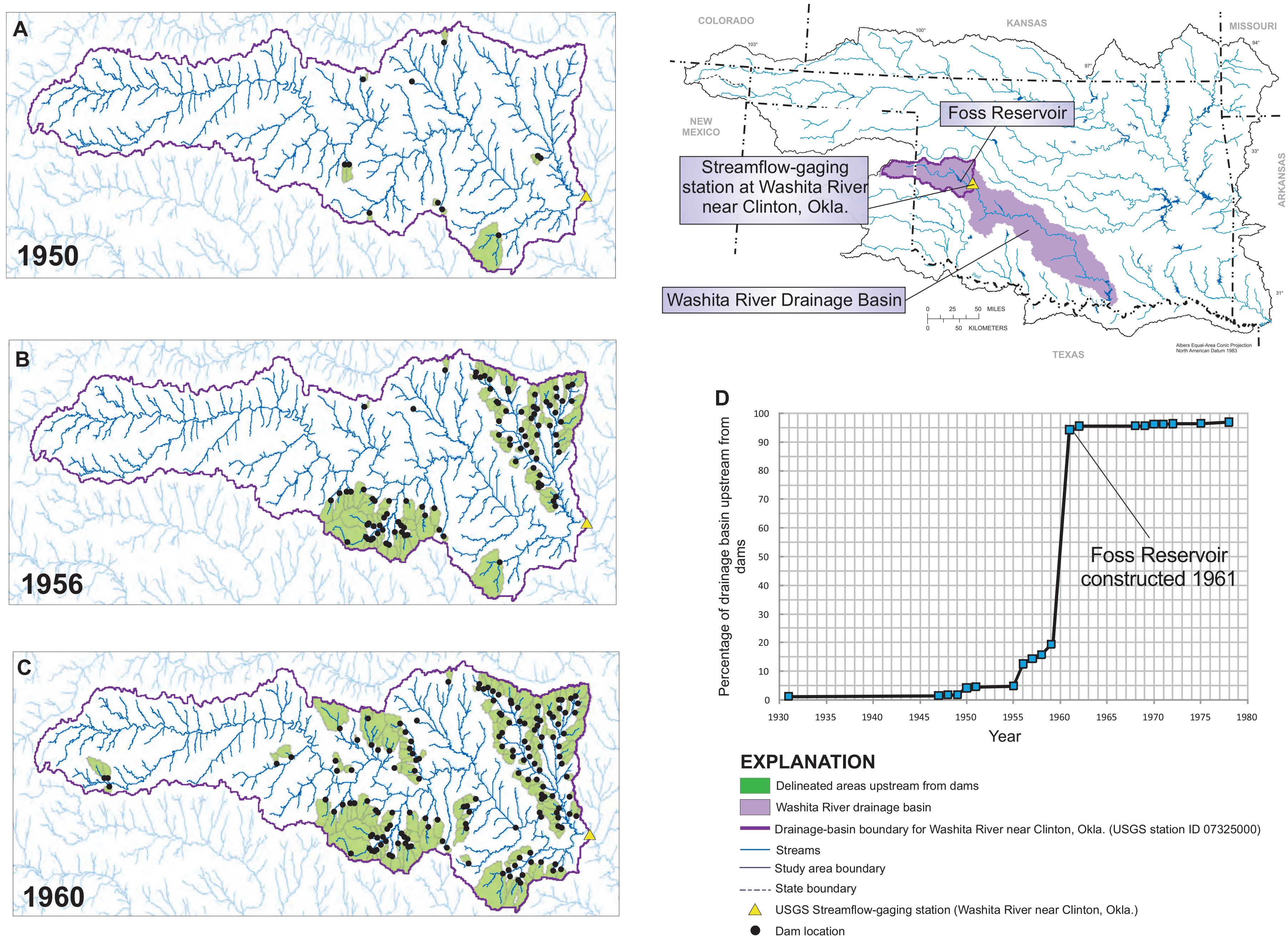

Figure 4. Delineated areas upstream from dams in the basin draining to the U.S. Geological Survey streamflow-gaging station, Washita River near Clinton, Oklahoma, (station ID 07325000) as of (A) 1950, (B) 1956, (C) 1960, and (D) the percentage of the drainage basin upstream from dams with time.

with anthropogenic activity during the preliminary least-altered periods. This analysis was used to detect any additional changes in the basin during the preliminary least-altered period that were not accounted for in historical information or the analysis of the extent of regulation as indicated by the number of dams in the drainage basin.

Statistical trend analysis of annual base flow in inches, annual total flow in inches, annual runoff in inches, and annual base-flow index (the ratio of base flow to total flow) was used. Trends in annual base flow, runoff, total flow, and base-flow index may indicate large-scale anthropogenic alteration to a stream or in a drainage basin. Downward trends in base flow, runoff, and total flow might indicate that direct surface-water withdrawals are increasing in the basin. Downward trends in base flow also may indicate that the magnitude and extent of groundwater withdrawals are increasing in the basin. An upward or downward trend in base-flow index may indicate an increase in surface-water or groundwater withdrawals, or a change in the way that water is being withdrawn. Upward trends in base flow and base-flow index may indicate that streams are receiving irrigation returns, or that infiltration is increasing in the basin. Infiltration in the drainage basin may happen because of an increasing number of impoundments in the drainage basin that may induce recharge, or because of increasing precipitation in the drainage basin caused by climate change.

Visual Trend Analysis and Selection of Stations for Further Statistical Analysis

Annual base flow, runoff, total flow, and base-flow index were calculated from daily mean streamflow record by using the Base-Flow Index program (Institute of Hydrology, 1980; Wahl and Wahl, 1995). Annual plots of these parameters for stations that had at least 20 years of streamflow record were created and visually analyzed to identify potential changes in streamflow. If a noticeable change in any of the annual streamflow parameters were detected, then the station was further considered for statistical trend analysis. If no noticeable change in annual streamflow parameters were detected, then an assumption was made that there would be no statistical trend; therefore, a statistical trend test was not performed. This assumption was made to reduce the need to perform statistical analysis on data from a large number of stations and increase efficiency of the analysis procedures.

Even though 10 years of streamflow record can be considered adequate for a baseline period, for this report, 10 years was not considered an adequate streamflow record length to draw conclusions from trends caused by anthropogenic activities during the least-altered period. Usage of only 10 years of streamflow record in visual and statistical time-based trend analysis may be misleading because of insufficient data. For example, if a 10-year period contains a climate cycle that includes wet and dry periods, but starts in a dry period and ends in a wet period, this cycle may be mistaken for a trend caused by human activities rather than climate. For these reasons, 20 years of streamflow record were selected as a minimum number of years for visual trend analysis. If less than 20 years of streamflow data were available prior to the start of substantial regulation or known irrigation (Wahl and Tortorelli, 1997), visual trend analysis was not performed. If the station had 20 years or more of streamflow data available prior to the start of substantial regulation or irrigation, only those 20 years or more of data were analyzed.

Upward trends observed from inspection of data plots at many stations indicated that base flow and runoff increased in the early to mid-1980s. Concensus from literature and precipitation data from the early to mid-1980s to around the year 2000, indicated much of the state experienced an unprecedented wet period (Garbrecht and Schneider 2007; Oklahoma Climatological Survey, 2007; Oklahoma Water Resources Board, 2007). For this report, the period between 1980 and 2000 is referred to as the “wet period” with respect to annual precipitation. An observed upward trend in base flow, runoff, or total flow, or any observed trend in base-flow index, during this the wet period was assumed to be caused by climate rather than anthropogenic activity. In this case, the span of the least-altered period was not reduced, and further analysis was not needed to refine the least-altered period.

Analysis of Covariance of Double-Mass Curves

Analysis of covariance of double-mass curves (Searcy and Hardison, 1960) was used as an additional tool to determine whether changes in streamflow characteristics, not related to climate variability, could be detected. A double-mass curve is a 2-dimensional linear plot of the cumulative data value of one variable over the cumulative data value of a second variable during coincident years (fig. 5). For this analysis, annual streamflow (annual base flow, annual runoff, and annual total flow) at the test station was plotted along the x-axis, and annual precipitation, during the same year, was plotted along the y-axis.

An abrupt change in the slope of the double-mass curve, referred to as a “breakpoint,” indicates a change in hydrologic conditions at the test station and the year of breakpoint can be interpreted as an appropriate end of the least-altered period. An assumption was made that a change in the relation between streamflow and precipitation at the test station is observed when plotted as a double-mass curve, that the change is caused by anthropogenic alteration of streamflow and not caused by a change or trend in climate. On the basis of these assumptions, a change in the streamflow trend with time may be caused by anthropogenic activity that has led to increased alteration of the streamflow regime.

Analysis of covariance (ANCOVA) of double-mass curves was performed for stations in which trends were visually detected that may be associated with anthropogenic activity. ANCOVA was used to test the significance of potential breakpoints on each double-mass curve, as described in Searcy and Hardison (1960). In this method, a variance-ratio test (or “F-test”) (Snedecor, 1934) is used to determine the probability (p) that the null hypothesis of no difference among slopes of the line segments before and after the breakpoint can

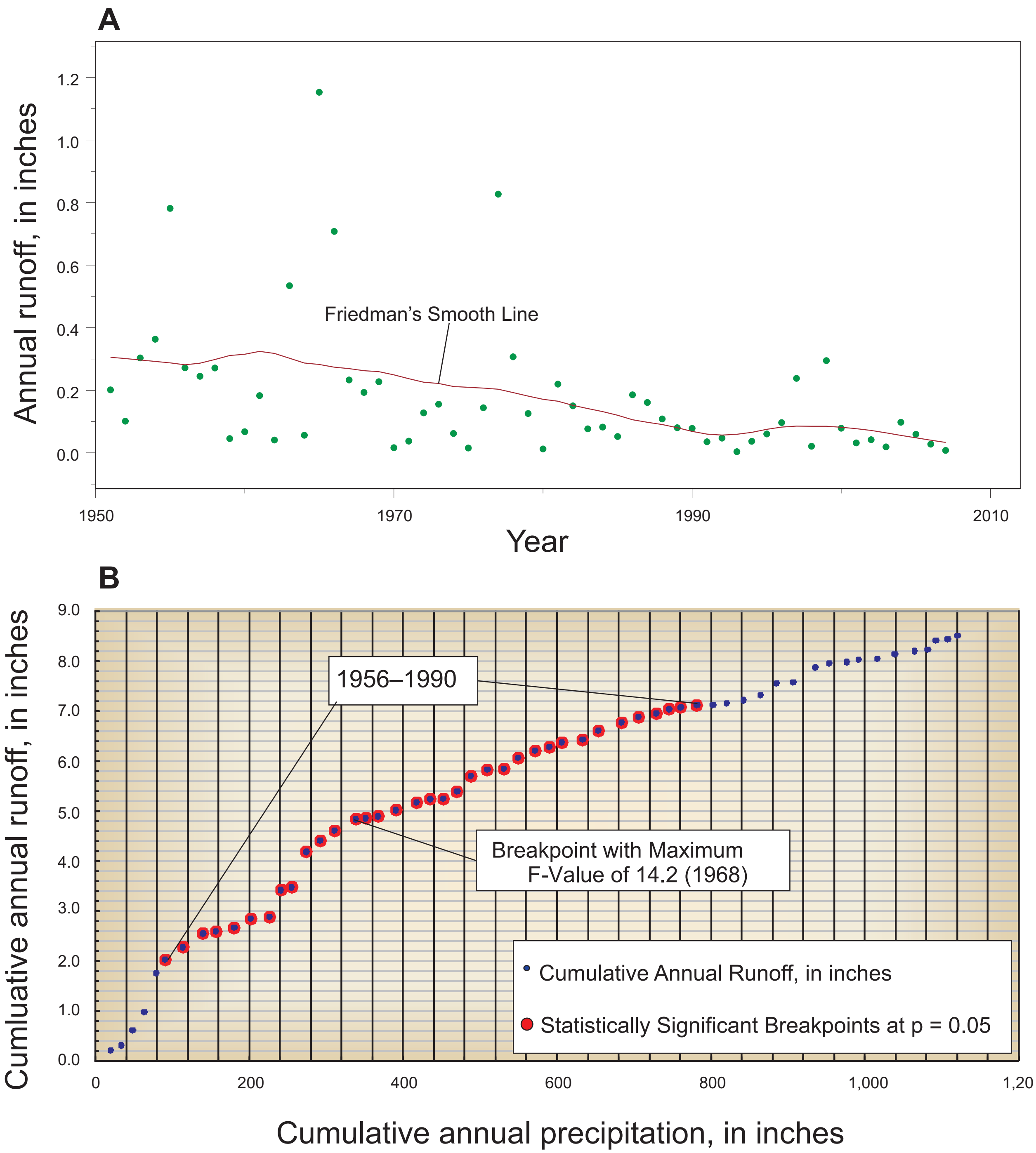

Figure 5. Example of (A) a time series plot of annual runoff and a Friedman's smooth trendline (Friedman, 1984), and (B) a double-mass curve for cumulative annual precipitation and cumulative annual runoff at Cimarron River near Kenton, Oklahoma, (USGS station identifier 07154500) showing breakpoints that indicate changes in the slope of the relation between precipitation and streamflow.

be rejected with a critical p-value less than or equal to 0.05. Searcy and Hardison (1960) reported that the ANCOVA test can be applied after visually inspecting the double-mass curve to identify possible breakpoints.

Esralew and Baker (2008) reported that a minor breakpoint in the double-mass plot may be easy to overlook and may only identify those breakpoints that are the most visually evident. Visually evident breakpoints may not be the same as the breakpoint with the largest F-value, so a visually evident breakpoint may not be the strongest statistical breakpoint. Therefore, all points on each double-mass curve were tested as potential breakpoints, and slopes of the line segments before and after each point were compared. This step facilitated the interpretation of breakpoints that are not evident visually as single points but as gradual changes in slope. This interpretation may indicate, for example, which changes such as increases in farm impoundments or other basin irrigation activities are gradually altering streamflow characteristics.

Limitations apply to this approach that warrant careful consideration of the results from ANCOVA tests, which is discussed in Wigbout (1973). One notable limitation is the F-test is sensitive to variability (scatter) in each of the two line segments. The F-test compares the variability in annual streamflow among periods to the variability in annual streamflow in periods so comparing line segments with high coefficients of determination (R^2) may lead to the designation of a minor inflection in slope as significant (Searcy and Hardison, 1960; Wigbout, 1973; Esralew and Baker, 2008). Therefore, in addition to significance as determined by ANCOVA, visual inspection of double-mass curves, such as visual evaluation of slope changes and breakpoint prominence, were used to determine whether substantial changes in streamflow were indicated in years in which a breakpoint was identified.

Double-mass curves were created to relate annual baseflow, annual total-flow, and annual runoff to annual precipitation for the climate division for each station selected for analysis. Double-mass analysis was not performed for base-flow index data because the units (unitless ratio) are not the same as that for annual precipitation. All years in which the ANCOVA critical F-value (p=0.05 significance level) was exceeded were identified as possible breakpoints for each double-mass curve. Breakpoints were visually examined to determine whether statistically significant breakpoints most likely represented substantial changes in the annual streamflow parameter being evaluated.

When the double-mass method was selected to analyze changes in streamflow, an assumption was made that breakpoint years would be detected only when the relation between streamflow and precipitation measurably changed. Even though this assumption would only highlight those trends that are not related to changes in climate, this assumption was not always appropriate. Preliminary observations indicated that some upward trends in cumulative annual streamflow may be detected in the double-mass analysis at the start of the wet period. The relation between precipitation and runoff is not necessarily linear. A nonlinear relation between cumulative annual streamflow and cumulative annual precipitation may be caused by changes in the duration and frequency of precipitation during wetter periods compared to drier periods or by increases in base flow from recharge as a result of a series of years with above-normal precipitation. This nonlinearity of the relation between precipitation and streamflow may result in statistically significant breakpoints. These changes in precipitation would not always be apparent when plotting annual precipitation. Therefore, if the breakpoint years showed an increase in base flow, runoff, or total flow starting in the early to mid-1980s, which is likely associated with increased precipitation during the wet period, then an assumption was made that the breakpoint was likely associated with changes in climate and not anthropogenic activity; no further statistical analysis was performed for that station. Further analysis of significant trends in annual streamflow adjusted for changes in precipitation would help to evaluate whether trends in streamflow are associated with climate (Esralew and Lewis, 2010).

Kendall's Tau Analysis

In the previous step of the analysis, suspected breakpoints were determined that might be used to eliminate nonbaseline years and refine the least-altered period. Stations that had breakpoints detected from double-mass analysis assumed to be related to anthropogenic activity (and not because of the wet period) were further analyzed to calculate trends in streamflow during the least-altered period by using a Kendall's tau test.

Kendall's tau test is a nonparametric statistical test that can be used to indicate the likelihood of an upward or downward trend with time. Information about the Kendall's tau test can be found in Sen (1968) and Kendall and Gibbons (1990). This test is effective for identifying trends in streamflow because extreme data points or skewness in the data have a minimal effect on the outcome of the trend analysis (Helsel and Hirsch, 1992). Kendall's tau test also was used to analyze trends in peak flow and mean annual streamflow by Tortorelli and others (2005), the base flow, runoff, and total flow of selected stations in the Beaver/North Canadian Basin (Wahl and Tortorelli, 1997) and the North Fork Red River Basin (Smith and Wahl, 2003), and base flow, total flow, and base-flow index for selected stations throughout Oklahoma with long-term streamflow record (Esralew and Lewis, 2010). Tau is a dimensionless measure of the correlation between the annual streamflow parameter and time (year), in which positive and negative signs indicate the direction of the trend. A trend is considered to be statistically significant if the null hypothesis of no trend in streamflow with time is rejected. The critical probability (p-value) for rejection of the null hypothesis is set at 0.05 for this report. The trend slope is a measure of the magnitude of the trend and was computed by using Sen slope estimator (Sen, 1968; Helsel and Hirsch, 1992).

The Kendall's tau test was run for annual base flow, annual runoff, and annual total flow for the period of record or the preliminary least-altered period, and for periods before and after suspected breakpoints determined from the double-mass analysis. Periods before and after suspected breakpoints that were identified for further analysis from the double-mass procedure are referred to in this report as "sub-periods". The Kendall's tau test was used to identify additional trends in streamflow remaining during the sub-periods of record to refine the least-altered period. Kendall's tau also was calculated for base-flow index data for all sub-periods.

At least 15 years of streamflow record in the sub-periods tested were required to run the test to minimize the possibility that trends determined from the Kendall's tau test were not because of climate fluctuations. This minimum required period was reduced from 20 years (used for the visual trend analysis), because many of the sub-periods identified from the double-mass analysis were less than 20 years.

Trends detected during any sub-period were used to determine if that period of record should be retained for consideration as the least-altered period, whether to reduce the quality rank of the least-altered period, or whether the station does not have a suitable least-altered period. A statistically significant trend detected in streamflow during the preliminary least-altered period (as identified from steps A and B, fig. 2) not related to climate would indicate that an anthropogenic change may have affected streamflow.

The longest period of record prior to a breakpoint year that did not result in a statistically significant trend because of the Kendall's tau test was selected as a potential least-altered period for each streamflow parameter. Then the shortest potential least-altered period for all streamflow parameters was selected as the final least-altered period. For example, if the longest period of record prior to a breakpoint year that did not result in a statistically significant trend was 1939–1969 for base-flow index and 1939–1965 for base flow, then 1939–1965, the shorter of the two periods, was selected as the final least-altered period.

Quality ranks were adjusted only if a lesser degree of regulation or other anthropogenic activity (determined from steps A and B of phase 1) during a new shortened least-altered period was determined from this analysis. For example, if a station with a period of record from 1945–2007 was affected by minor wastewater effluent since 1985 that resulted in a quality ranking of "fair", but the new least-altered period determined from this phase was 1945–1982, then the quality ranking would be adjusted to "excellent".

The statistical procedures described were used to eliminate nonbaseline years from the preliminary least-altered period. However, because changes in annual streamflow parameters only represent selected elements of the streamflow regime, a substantially altered period of record may be overlooked by the trend analysis procedures used in this report if anthropogenic activities do not have a visible effect on annual streamflow parameters. For example, some anthropogenic activities such as in-stream diversions or increases in impervious surface may affect the timing or rate of streamflow change, which may not necessarily change the total annual streamflow volume. Because of these limitations, the number of years in the least-altered period of record determined from previous steps were not increased if no statistical changes could be detected by using the methods described. This conservative assumption was used to decrease the likelihood that a substantially altered period of record would be designated as a baseline period.

Several previous publications used similar procedures to assess trends in base flow and total flow. Wahl and Tortorelli (1997) performed a Kendall's tau trend analysis for selected stations in the Beaver-North Canadian River Basin upstream from Canton Lake, and Smith and Wahl (2003) performed a Kendall's tau trend analysis for selected stations in the North Fork Red River Basin. The degree of alteration because of irrigation activities for stations in those basins was determined in both studies. Trend analysis was still performed for these stations in this report because the years of analysis were different than those years used in both studies.

Determination of Optimum Minimum Period of Record to Represent Climate Variability

An analysis was performed to determine the minimum number of years of precipitation record needed to accurately represent climate variability during 1925–2007. Durations of 5 to 35 years were evaluated for each of the 20 climate divisions that contained stations selected for analysis (fig. 3).

The period 1925–2007 was divided into overlapping moving sub-periods of 5-, 10-, 15-, 20-, 25- and 35-year periods for each climate division. For example, for 10-year periods, the period 1925–2007 was broken up into periods of 1925–1934, 1926–1935, 1927–1936 and so on. The distribution of annual precipitation was compared for each consecutive overlapping 5-year period to the period 1925–2007 by using a Wilcoxon rank-sum test (Wilcoxon, 1945), for each climate division. The test was repeated for the remaining 10-, 15-, 20-, 25-, and 35-year periods.

The null hypothesis specified no difference in the distribution of annual precipitation of the sub-period and the period 1925–2007. A p-value was calculated from the Wilcoxon rank-sum test. The results of this test indicate the probability that a difference exists in the distribution of annual precipitation between the two periods, with the critical p-value set at less than or equal to 0.05. The optimum minimum period of record for each climate division was defined as the shortest sub-period for which the null hypothesis was not rejected for any of the overlapping sub-periods.

Annual rainfall is dominated by relatively consistent alternating periods of wet and dry that typically last 5 to 10 years, but from the early 1980s to around the year 2000, Oklahoma experienced an unprecedented wet period (Garbrecht and Schneider 2007; Oklahoma Water Resources Board, 2007). Recent and historical data indicate that hydrologic droughts in Oklahoma occurred in water years 1929–1941, 1952–1956, 1961–1972, 1976–1981, and most recently 2006 (Tortorelli and others, 2005; Oklahoma Water Resources Board, 2007). In addition, characteristics of typical climate variability including the wet period may be different depending on climate division (Garbrecht and Schneider, 2007).

The optimum minimum period of record was defined separately for sub-periods starting or mostly ongoing in the wet period, and sub-periods starting in the historically normal climate period (prior to 1980). This procedure was used to reflect the likelihood that the period from the early 1980s to the year 2000 was an uncharacteristically wet period when compared to earlier years. Statistical rejections for 5- and 10-year sub-periods were tallied separately for sub-periods starting in 1925 through 1980, and sub-periods starting in 1981 through 2007. The cut-off year for defining the wet period started in 1970 for the 15-, 20-, and 25-year sub-periods. A wet-period analysis was not performed separately for the 35-year periods.

The optimum minimum number of years for a baseline period was identified for each station by comparing the least-altered period to the minimum number of years determined for the climate division in which the station was located. Streamflow during least-altered periods of record with 50 percent or more of the years after 1980 were considered to be substantially affected by the wet period. The optimum minimum number of years for a baseline period determined for the wet period was applied to stations in which the least-altered period met this criteria. The quality ranking was lowered by one level (for example a “fair” baseline period would be reduced to a “poor” baseline period) for stations that had less than the optimum minimum number of years of streamflow record for a baseline period. If the least-altered period was already “poor”, the quality ranking was not changed.

The Wilcoxon rank-sum test also was run for annual precipitation for the least-altered period for each station compared to a long-term period, 1925–2007, for the same climate division. This procedure was used to determine if the least-altered period determined from the previous steps was adequate enough in length and happened during an appropriate time period to be representative of annual climate variability.

If the p-value was at or below the critical value of 0.05, the null hypothesis of a representative period of record was rejected and the station was considered not to have a suitable baseline period for use in modeling applications. If the p-value was at or below a critical value of 0.1, the quality ranking for the baseline period was reduced to “poor”. Stations that were already previously ranked “poor” were not removed from consideration.

Determination of the Baseline Period of Record

Least-Altered Period of Record

One hundred and seventy-one stations were initially considered in the first step of the least-altered period selection process. Table 1 (back of report) lists the known anthropogenic alteration determined from historical information. The table also lists the preliminary quality ranking for the station, which was assigned by using professional judgment, on the basis of the historical information pertaining to human alteration determined for each station. Fifty-five stations were eliminated during this step of the analysis from further consideration in the baseline period analysis because of substantial alteration. If a station was eliminated from consideration, the baseline quality rank was marked “no baseline period” (table 1).

One hundred and sixteen stations that had 10 years of least-altered streamflow record as determined from the first step of the process to determine the least-altered period of record (phase 1, step A, fig. 2) were considered in the second step of the process (phase 1, step B, fig. 2) and are listed in table 2 (back of report). One station, Gaines Creek near Krebs (07232000) with a preliminary quality rank of “excellent” from the previous step, could not be analyzed during the second step because the station was inundated by Lake Eufala and digital drainage information was unavailable (accurate delineations could not be performed). An assumption was made that regulation of streamflow at this station prior to the completion of Lake Eufala was negligible. The table lists the year that 1, 5, 10, and 20 percent regulation by dams were reached for the station during the full period of record and lists the quality rank adjustment that was assigned for the degree of regulation. The preliminary baseline period for 20 stations was reduced and the quality ranking for 73 stations was changed because of the second step of the least-altered period of record analysis (phase 1, step B, fig. 2). The quality ranking for two stations were changed to “no baseline period”. The quality ranking for Illinois River at Savoy (07194800), in which about 19 percent of the drainage area was affected by regulation for the period of record, was changed to “no baseline period.” The quality ranking for Salt Fork Red River near Elmer (07301110) was changed from “poor” to “no baseline period” because streamflow is likely affected by substantial anthropogenic activity. More than 15 percent of the drainage basin was affected by regulation for the period of record and historical station notes indicated that streamflow was affected by irrigation returns.

Of 114 stations that had a preliminary least-altered period from the second step of the least-altered period analysis (phase 1, step B, fig. 2), 74 stations with 20 or more years of streamflow record prior to the start of substantial regulation or known irrigation (Wahl and Tortorelli, 1997) were analyzed for visual trends in annual base flow, runoff, total flow, and base-flow index (table 3, back of report) as part of the third step of the process (phase 1, step C1, fig. 2). Only data from the years prior to substantial regulation or irrigation were analyzed. Visual inspection revealed that 31 stations had detectable and directional trends in some or all four streamflow parameters during the period of streamflow record prior to substantial regulation. Of those stations, the upward trends in some or all annual streamflow parameters or upward or downward trends in base-flow index at 22 stations were likely associated with the start of the wet period in the early 1980s and an assumption was made that the visual trends were not because of anthropogenic activities such as diversions, withdrawals, regulation, or effluent at these stations. Visual trends were detected during the analysis period for 12 stations for some or all streamflow parameters that were assumed to be unassociated with the wet period. A substantial gap in the least-altered period was identified for Salt Fork Arkansas River near Alva (07148400) (29 years). Double-mass and Kendall’s tau tests could not be used to analyze the full dataset because of the streamflow record gap. For this station, base flow was generally higher and runoff was generally lower for the earlier period 1939–1951 than the later period, which indicates that the cause of the trend occurred from 1951–1979; therefore, 1939–1951 was assumed to be the least-altered period without further analysis.

Analysis of covariance of double-mass curves were performed for 11 stations identified for analysis from the previous step (phase 1, step C2, fig. 2). Table 4 (back of report) shows the results of the double-mass analysis, including statistically significant breakpoint years in which the analysis of covariance and visual interpretation of the results indicated a substantial change in the rate of change of the annual flow parameter relative to precipitation. For each station, the likelihood that the breakpoint year or years associated with the start of the wet period was determined (table 4). Of 11 stations in which the double-mass test was run, 9 stations were selected for further analysis by using the Kendall's tau test (phase 1, step C3, fig. 2).

Results are listed in table 5 (back of report) for the Kendall's tau test for stations in which the test was performed and changes to the least-altered period resulting from this analysis. The quality ranking for Clear Creek near Elmwood (07234100) was changed from "poor" to "no baseline period" because significant downward trends in total flow and runoff were detected during the full period of record, 1966–1993, and the period before the breakpoint identified from double-mass analysis, 1974, was less than 10 years of streamflow record. Significant trends in base-flow index, total flow, or runoff were not detected for the period 1975–1993. This result supported the observation that a substantial change to the streamflow regime happened in mid-1970s. A similar result also was observed by Wahl and Tortorelli (1997), who noted that regional irrigation activities in the Beaver/North Canadian River Basin (which contains this drainage basin) substantially affect streamflow. The least-altered period and quality ranking also were adjusted for Medicine Lodge River near Kiowa, Kansas, (07149000). The end of the least-altered period, 1969, was changed to a year prior to when 5 percent, but after when 1 percent, of the drainage basin was upstream from dams (1968), and resulted in a change in the quality ranking from "fair" to "good".

Optimum Minimum Period of Record

The optimum minimum period of record for each climate division is listed in table 6. Results of the analysis indicated that optimum periods of record for climate divisions ranged from 10 to 35 years for the normal period (prior to 1980) and after the start of the wet period (1980). In general, during the period prior to the start of the wet period, stations in northeast Oklahoma and southwest Missouri, and stations in southwest Oklahoma, require a longer streamflow record than stations in other areas to include a climate that is representative of the longer period (fig. 6). In contrast, stations in central and southern Oklahoma and southwest Arkansas need more streamflow record after the start of the wet period compared with surrounding climate divisions. Stations located in many of the climate divisions had optimum minimum periods of record of 15 or more years for periods of record that mostly occurred prior to the wet period, and 20 or more years of streamflow record for periods of record mostly occurring during the later wet period. Twenty-seven stations had quality rankings that were changed because of this phase of the analysis (phase 2, step A, fig. 2). Final quality rankings for each station because of this analysis are listed in table 7 (back of report). Stations that did not have a baseline period because of previous analyses are not listed in table 7.

Annual precipitation during the least-altered period for 113 stations was compared to the period 1925–2007 to determine if the least-altered period happened during an appropriate time period to be representative of a annual climate variability (phase 2, step B, fig. 2). The least-altered periods for two stations, Sweetwater Creek near Sweetwater (07301420) and Salt Creek near Okeene (07158400), were removed from consideration as a baseline period because the critical p-value for annual precipitation for the least-altered period was less than or equal to 0.05 from the Wilcoxon rank-sum test. Four other stations had p-values that were greater than 0.05 but were less than 0.1. Stahl Creek near Miller, Missouri, (07185500) and Spring River at LaRussell, Missouri, (07185700) had a baseline period initially ranked "excellent" from previous analysis, but were changed to "poor". Washita River near Clinton, Oklahoma, (07325000) and Bird Creek at Avant, Oklahoma, (07176500) already had a preliminary least-altered period that was ranked "poor", so the quality ranking was not changed for the baseline period because of this analysis.

Final Baseline Period

A final baseline period and quality ranking were determined for 111 stations (65 percent of stations analyzed). Of 171 stations analyzed for a baseline period, a suitable baseline period for modeling applications could not be identified for 60 stations (35 percent of stations analyzed). A baseline period could not be identified for 58 stations because of substantial anthropogenic alteration of the stream or drainage basin and for 2 stations because the least-altered period of record was not representative of annual climate variability. Table 7 (back of report) lists the baseline period determined for each station (if the station had a baseline period) and the associated quality ranking of the baseline period (fig. 7). Stations that do not have a baseline period are not listed in table 7. In figure 6, a quality ranking of "no baseline period" was assigned to stations from table 1 (back of report) that did not have a baseline period.

Baseline periods were rated as "excellent" for 22 stations, "good" for 42 stations, "fair" for 24 stations, and "poor" for 23 stations. Out of 22 stations with baseline periods that were rated "excellent", 12 stations were in southeastern Oklahoma (defined as tributaries that drain to the Red River downstream from Lake Texoma, fig. 7). No clear spatial patterns in the location of stations with baseline periods rated "good", "fair" and "poor" were apparent.

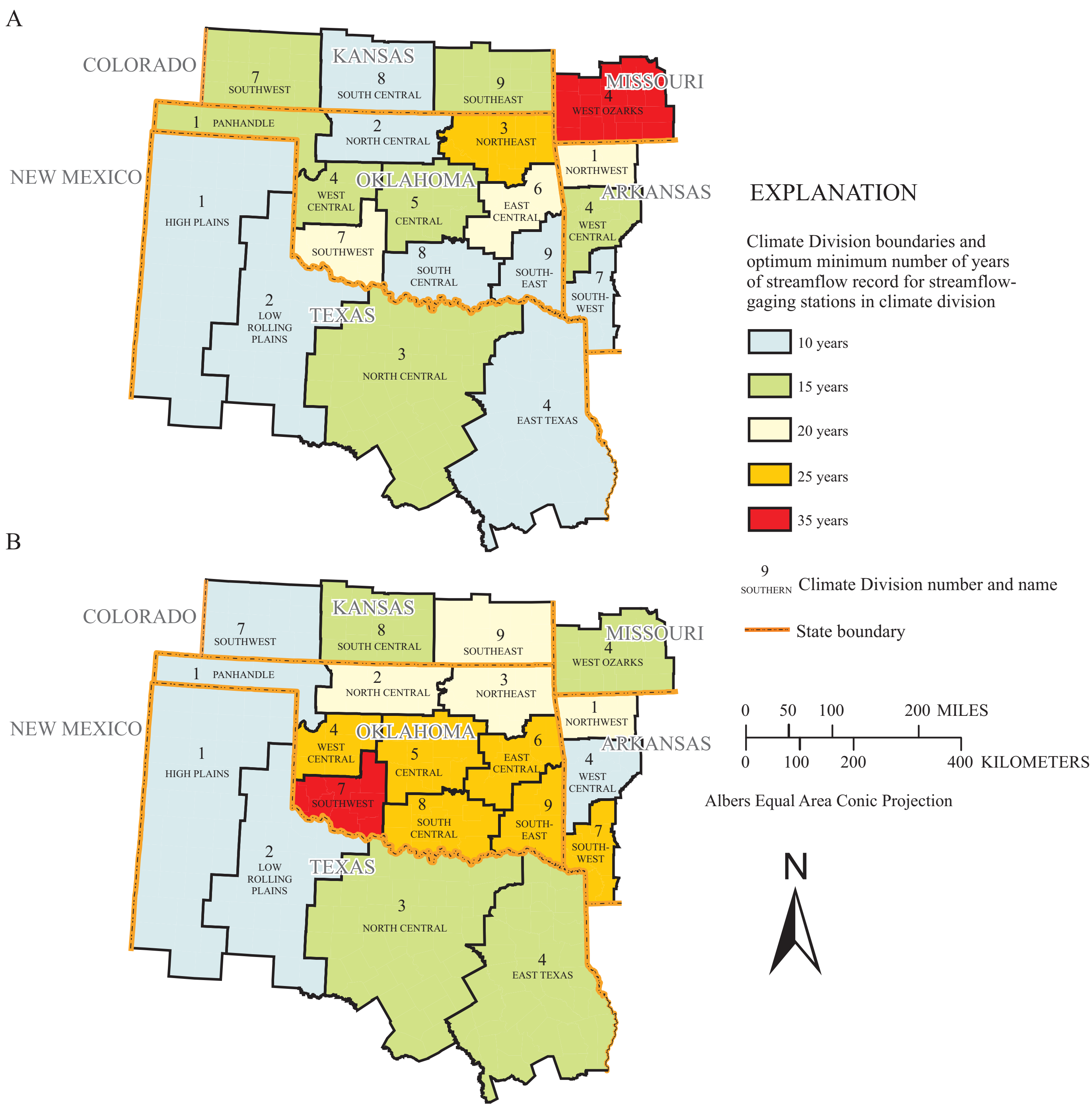

Figure 6. Climate divisions used in the process to determine a baseline period of record for selected streamflow-gaging stations in and near Oklahoma, and the optimum minimum number of years of streamflow record needed for the baseline period for streamflow-gaging stations in those climate divisions, defined separately for gages located in each climate division for (A) periods of record where more than 50 percent of years occurred prior to 1980, the historically normal period, and (B) periods of record where more than 50 percent of years occurred after 1980s, the historically wet period.

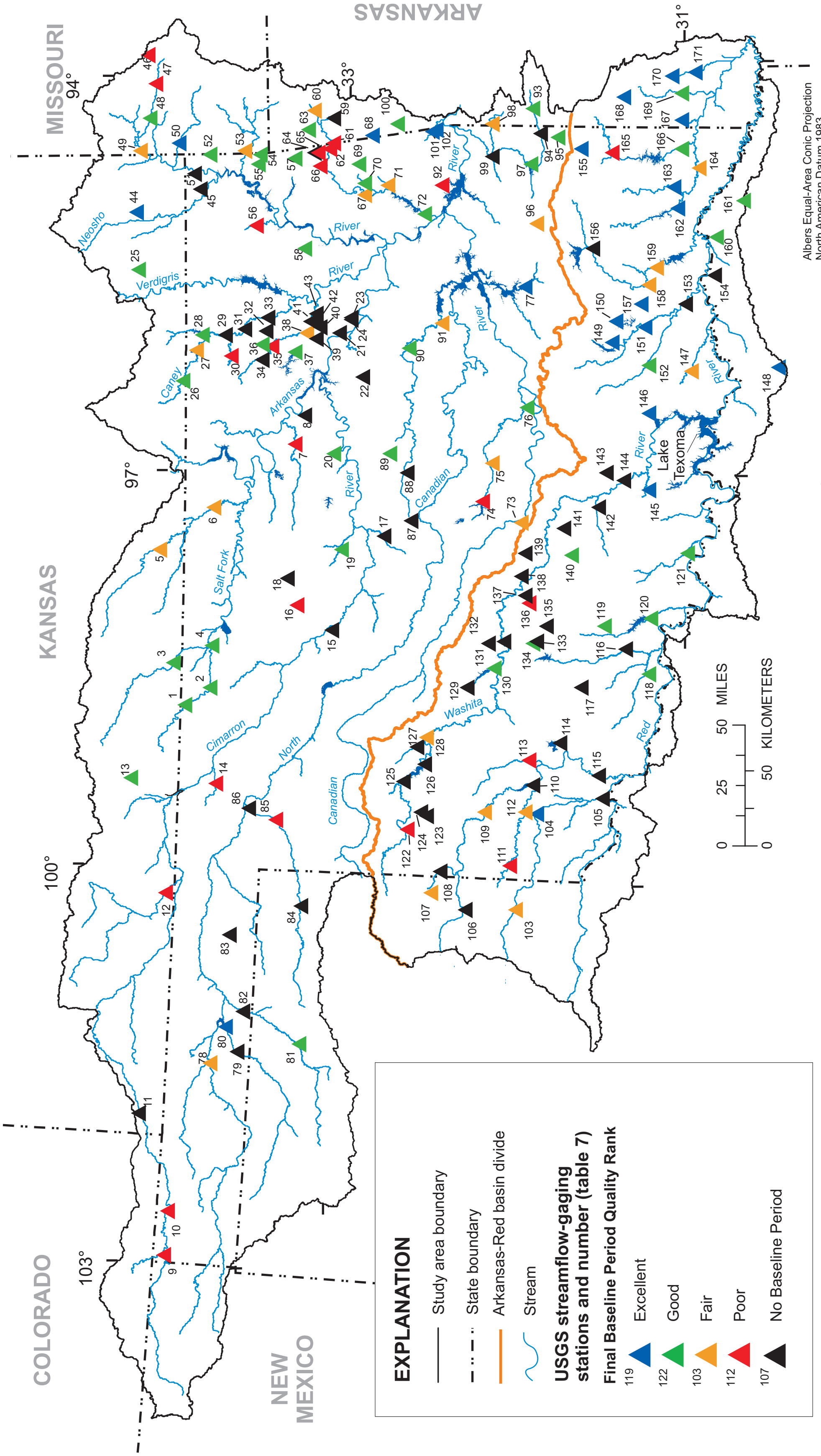

Figure 7. Selected USGS streamflow-gaging stations with a period of record of 10 or more years, and the final baseline period quality ranking for each station.

Baseline periods represented a wide range of years, starting with 1924 and included baseline periods that extended through 2007. Baseline periods ranged from 10 years to 84 years, with an average of 26 years. Of 111 stations with a baseline period, 83 percent of stations had a baseline period that was less than 40 years. Of the stations with a baseline period, more than 80 percent of stations had baseline periods that included one or all years between 1949 and 1964. Twenty-seven percent of stations had baseline periods that included any of the years between 1924 and 1939. Thirty-five percent of stations included years after 1981, indicating that most stations in this report do not have baseline periods that extend through the wet period. Even though the years 1940–1980 were better represented by baseline periods than years before or after this period, a concurrent baseline period for all stations could not be established. No single year was indicated when more than 60 percent of stations had baseline periods that contained that year. This inconsistency may have been the result of increases in regulation after the 1960s, especially with large-scale construction of Natural Resources Conservation Service (formerly Soil Conservation Service) dams (Tortorelli, 1997 and 2002; Lewis and Esralew, 2009; Smith and Esralew, 2009), and short-term maintenance of unregulated stations with drainage areas less than 2,500 square miles.

Anthropogenic activity that may affect streamflow during the baseline period was noted for 44 stations. The most commonly noted anthropogenic activity for stations that had baseline periods was minor regulation. Twenty-two stations had baseline periods that were affected by minor regulation as indicated by the number of dams in the drainage basin (including two stations that were affected by backwater from nearby regulation) 12 stations had baseline periods that were affected by diversion or withdrawal, 12 stations had baseline periods that were affected by irrigation activity, and 3 stations were affected by effluent. More than one type of anthropogenic activity was noted for eight stations.

Summary

Use of historical streamflow data from a least-altered period can enhance water resources planning by using these data in calibration of various watershed modeling applications. This information is especially useful for watershed models that are used to characterize least-altered streamflow and predict the effects of proposed streamflow alteration. To address this need, the U.S. Geological Survey, in cooperation with Oklahoma State University and the Oklahoma Water Resources Board, determined baseline periods of record for selected streamflow-gaging stations that can be used as a calibration dataset for modeling applications. The baseline period was defined as a period that is least-altered by anthropogenic activity and has sufficient streamflow record length to represent the extreme wet and dry periods included in typical annual climate variability. Streamflow data from 171 stations in and near Oklahoma with a minimum of 10 complete water years of daily streamflow record through water year 2007 and drainage areas that were less than 2,500 square miles were considered for use in the baseline-period analysis.

In the first step of the process to determine the least-altered period, historical basin information was used to identify anthropogenic activities in each drainage-basin that may affect streamflow. Station information was evaluated by using previous publications, historical station record notes, and information gathered from oral and written communication with U.S. Geological Survey hydrographers familiar with selected stations. This information was used to eliminate streamflow record from selected stations to identify a preliminary least-altered period. Quality rankings were assigned for each preliminary least-altered period on the basis of professional judgment of the suspected degree of alteration as determined from this step.

The second step was to determine for the least altered period, the stations that had substantial effects from upstream regulation by documenting the location of dams in the drainage basin. The drainage area upstream from the dams was determined and the percentage of the total drainage area for the station that was affected by dams was calculated. The year that the dams were completed was used to construct a plot of downstream drainage area affected by dams with time. The least-altered period was refined from the previous step by either (a) excluding years in which the percent of the drainage area upstream from dams ranged from 1 percent to 20 percent if at least 10 years of streamflow record remained after the years were excluded, or (b) modification of the quality rank for the period of record on the basis of the percentage of the drainage area affected by dams.

The third step of the determination of the least-altered period was visual analysis of annual hydrographs, and included analysis of covariance of double-mass curves and Kendall's tau analysis to detect statistically significant changes in base flow, runoff, total flow and base-flow index for selected stations.

Annual plots of these parameters for stations were created and visually analyzed to identify changes in streamflow. If the station had 20 years or more of streamflow data available prior to the start of substantial regulation or irrigation, as determined from steps 1 and 2, only those 20 years or more of data were analyzed. If a noticeable change in any of the annual streamflow parameters were detected but were not assumed to be caused by increases in precipitation, then the station was further considered for statistical trend analysis.

Double-mass curves were created to relate annual base flow, annual runoff, and annual total flow to annual precipitation for the climate division for each station selected from the visual hydrograph analysis. Statistical breakpoints identified by the double-mass analysis were visually examined to determine if the breakpoints most likely represented substantial changes in the annual streamflow parameter being evaluated.

A Kendall's tau trend test was run for annual base-flow, annual runoff, and annual total-flow for the the preliminary least-altered period determined from previous steps, and for sub-periods before and after suspected breakpoints determined from the double-mass analysis for stations with preliminary least-altered periods and sub-periods of at least 15 years of streamflow record. The test was used to identify additional trends in streamflow remaining during the sub-periods of record for a refined least-altered period. Trends detected during any sub-period were used to (1) determine if that streamflow record should be retained for consideration as the least-altered period, (2) reduce the quality rank of the least-altered period, or (3) determine that the stream does not have a least-altered period suitable for a baseline period.

An optimum minimum period of record was determined for each of the least-altered periods for each station to ensure that the least-altered period had a sufficient streamflow record length to provide a representative sample of climate variability. An optimum minimum period of 10 years or more were evaluated by analyzing the variability of annual precipitation for selected 5-, 10-, 15-, 25-, and 35-year periods for each of 20 climate divisions that contained stations used in the baseline period analysis. The distribution of annual precipitation was compared for each consecutive overlapping 5-year period to the period 1925–2007 by using a Wilcoxon rank-sum test. The least-altered period of record for stations also was compared to the period 1925–2007 by using a Wilcoxon rank-sum test. The results from the test were used to determine how many years of annual precipitation were needed for the distribution of annual precipitation for the selected least-altered period to be statistically similar to the distribution of annual precipitation for a long-term period (1925–2007).

Of 171 stations analyzed for a baseline period, a final baseline period and quality ranking were determined for 111 stations (65 percent of stations analyzed), and a suitable baseline period for modeling applications could not be identified for 60 stations (35 percent of stations analyzed). A baseline period could not be identified for 58 stations because of substantial anthropogenic alteration of the stream or drainage basin and for 2 stations because the least-altered period of record was not representative of annual climate variability. The baseline period for each station was rated“excellent”, “good”, “fair”, “poor”, or “no baseline period” on the basis of a qualitative evaluation of the approximate degree of basin alteration for the least-altered period, and whether or not the least-altered period was long enough to be representative of long-term climate variability. Baseline periods were rated as “excellent” for 22 stations, “good” for 42 stations, “fair” for 24 stations, and “poor” for 23 stations.

Eighty-three percent of stations with a baseline period had a baseline period of less than 40 years. Of 111 stations with a baseline period, more than 80 percent of stations had baseline periods that included the years 1949–1964. Thirty-five percent of stations included years after 1981, indicating most stations analyzed in this report do not have baseline periods that extend through the wet period. The most commonly noted anthropogenic activity for stations that had baseline periods was minor regulation.

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[ID, identifer; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; %, percent; ft, feet; ft^3/s, cubic feet per second; mi^2, square miles; station, streamflow-gaging station]

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Map number (fig. 1)	U.S. Geological Survey ID	Station name	Period of record (complete water years)	Comments[1]	Preliminary baseline period of record (complete water years)	Preliminary quality ranking[2]
1	07148350	Salt Fork Arkansas River near Winchester, Okla.	1960–1993	Conservation ponds and terracing are common in drainage basin.	1960–1993	Good
2	07148400	Salt Fork Arkansas River near Alva, Okla.	1939–1951, 1980–2007	Conservation ponds and terracing are common in drainage basin.	1938–1951, 1980–2007	Good
3	07149000	Medicine Lodge River near Kiowa, Kans.	1939–1950, 1960–2007	None	1939–1950, 1960–2007	Excellent
4	07149500	Salt Fork Arkansas River near Cherokee, Okla.	1941–1950	None	1941–1950	Excellent
5	07151500	Chikaskia River near Corbin, Kans.	1951–1965, 1976–2007	Streamflow may be slightly affected by groundwater withdrawals, diversions for irrigation, and return flow from irrigated areas.	1951–1965, 1976–2007	Good
6	07152000	Chikaskia River near Blackwell, Okla.	1937–2007	Some minor regulation at low flow by Lake Blackwell, 12.6 miles upstream from station, since 1950. Small diversion made from reservoir for municipal supply of city of Blackwell. Streamflow may be slightly affected by groundwater withdrawals, diversions for irrigation, and return streamflow from irrigated areas.	1937–1949	Fair
7	07153000	Black Bear Creek at Pawnee, Okla.	1945–2007	Some retention reservoir work was done by the Soil Conservation Service during the period of record to dampen flooding, and streamflow has been regulated since 1963 by numerous floodwater-retarding structures.	1945–1962	Fair
8	07153100	Ranch Creek at Cleveland Dam near Cleveland, Okla.	1946–1963	Station is located at intake tower at Cleveland Dam, and is completely regulated for the period of record.	None	No Baseline Period
9	07154500	Cimarron River near Kenton, Okla.	1951–2007	Diversions for irrigation of about 7,400 acres upstream from station.	1951–2007	Poor
10	07155000	Cimarron River above Ute Creek near Boise City, Okla.	1943–1954	Records include water diverted at Kohler's dam 1,000 ft upstream from station for sluicing of canal, from which the water returns to the stream just downstream from the station control, and for irrigation of about 650 acres downstream from station, from which the return streamflow enters stream 8.3 miles downstream from the station. Diversions for irrigation of about 8,600 acres upstream from station.	1943–1954	Poor
11	07155590	Cimarron River near Elkhart, Kans.	1972–2007	Extensive irrigation upstream from station for the period of record, extremely low flow or zero streamflow occurs often.	None	No Baseline Period
12	07157500	Crooked Creek near Englewood, Kans.	1943–2007	Diversion for irrigation of about eight irrigation wells adjacent to Crooked Creek upstream from station.	1943–2007	Poor

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13	07157900	Cavalry Creek at Coldwater, Kans.	1967–1980	None	1967–1980	Excellent
14	07157960	Buffalo Creek near Lovedale, Okla.	1967–1993	None	1967–1993	Excellent
15	07158400	Salt Creek near Okeene, Okla.	1962–1967, 1975–1979	Some streamflow diverted for three small ungated lakes at Roman Nose State Park.	1962–1967, 1975–1979	Good
16	07159000	Turkey Creek near Drummond, Okla.	1948–1970	Some diversions upstream for irrigation.	1948–1970	Fair
17	07159750	Cottonwood Creek near Seward, Okla.	1974–1982, 1990–2001	Streamflow regulated by numerous floodwater-retarding structures for the period of record. Low flow sustained in part by treated wastewater effluent from Oklahoma City.	None	No Baseline Period
18	07160350	Skeleton Creek at Enid, Okla.	1997–2007	Low flows minorly regulated by releases of effluent from the City of Enid wastewater treatment plant, 1 mile upstream. Basin is moderately urbanized (greater than 10% of area contains impervious surfaces).	None	No Baseline Period
19	07160500	Skeleton Creek near Lovell, Okla.	1950–1993, 2002–2007	Activities that affect upstream station, Skeleton Creek at Enid (07160350), most likely does not have a substantial affect on streamflow at this station.	1950–1993, 2002–2007	Excellent
20	07163000	Council Creek near Stillwater, Okla.	1935–1993	Weir and other channel modifications made in the early 1960s may have minor effects on low flow.	1934–1960	Good
21	07164600	Joe Creek at 61st Street at Tulsa, Okla.	1989–2007	Basin is substantially urbanized.	None	No Baseline Period
22	07165500	Polecat Creek below Heyburn Reservoir near Heyburn, Okla.	1944–1979	Streamflow completely regulated by Heyburn Lake since September 1950. Basin is substantially urbanized.	None	No Baseline Period
23	07165562	Haikey Creek at 101 Street South at Tulsa, Okla.	1989–2007	Basin is substantially urbanized.	None	No Baseline Period
24	07165565	Little Haikey Creek at 101st Street South at Tulsa, Okla.	1988–2007	Basin is substantially urbanized.	None	No Baseline Period
25	07170700	Big Hill Creek near Cherryvale, Kans.	1958–2007	Streamflow completely regulated since 1981 by Big Hill Lake (07170695), 1,200 ft upstream. Regulation is complete until lake elevation reaches 857.80 ft when water flows through an uncontrolled open chute.	1958–1980	Excellent

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26	07172000	Caney River near Elgin, Kans.	1940–2007	Streamflow regulated since 1965 by numerous floodwater-retarding structures.	1940–1964	Excellent
27	07173000	Caney River near Hulah, Okla.	1938–1993	Streamflow completely regulated since February 1950 by Hulah Lake (07172500) from which about 5 to 9 ft^3/s is diverted from gaging pool for municipal water supply by the city of Bartlesville.	1938–1949	Excellent
28	07174200	Little Caney River below Cotton Creek, near Copan, Okla.	1939–1980[3]	Streamflow regulated since 1969 by numerous floodwater-retarding structures. Station used to be 07174000 (Little Caney River near Copan), but was moved in 1958 prior to anticipated dam construction for Copan Lake, which was completed in 1983. Statistical analysis includes streamStreamflow record at the previous station from 1944–1958 water years.	1939–1968	Good
29	07174400	Caney River above Coon Creek at Bartlesville, Okla.	1986–2007	Streamflow regulated by Hulah Lake 27 miles upstream, and by Copan Lake 12 miles upstream. Diversion at station for municipal water supply by the city of Bartlesville.	None	No Baseline Period
30	07174600	Sand Creek at Okesa, Okla.	1960–1993	Streamflow may be affected by minor regulation from Sunset Lake since 1961.	1960–1993	Poor
31	07174700	Caney River near Ochelata, Okla.	1957–1976	Streamflow regulated by Hulah Lake for the period of record.	None	No Baseline Period
32	07175000	Double Creek Surface Water Station 5 near Ramona, Okla.	1956–1969	Streamflow regulated since 1955 by floodwater-retarding structures. Station is just downstream from a floodwater-retarding structure.	None	No Baseline Period
33	07175500	Caney River near Ramona, Okla.	1946–2007	Streamflow regulated since February 1951 by Hulah Lake, and since April 1983 by Copan Lake.	1946–1950	No Baseline Period
34	07176465	Birch Creek below Birch Lake near Barnsdall, Okla.	1978–1992	Streamflow completely regulated for the period of record by Birch Lake.	None	No Baseline Period
35	07176500	Bird Creek at Avant, Okla.	1946–2007	Streamflow slightly regulated since 1958 by Bluestem Lake, and substantially regulated since 1977 by Birch Lake, located 12 miles upstream. Small diversions upstream for municipal water supply for the cities of Pawhuska and Barnsdall. Immediately upstream from station, water may be diverted for use in freshwater flooding of oil wells.	1946–1976	Poor
36	07176800	Candy Creek near Wolco, Okla.	1970–1980	None	1970–1980	Excellent

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37	07177000	Hominy Creek near Skiatook, Okla.	1945–1980	None	1945–1980	Excellent
38	07177500	Bird Creek near Sperry, Okla.	1939–2007	Streamflow slightly regulated since 1958 by Bluestem Lake and substantially regulated since 1977 by Birch Lake. Streamflow regulated since October 1984 by Skiatook Lake. Farther upstream, the cities of Barnsdall and Pawhuska, Oklahoma, divert a small amount of water for municipal use. Also farther upstream at Avant, some water may be diverted for use in flooding oil fields.	1939–1957	Fair
39	07177650	Flat Rock Creek at Cincinatti Avenue at Tulsa, Okla.	1989–2007	Basin is substantially urbanized.	None	No Baseline Period
40	07177800	Coal Creek at Tulsa, Okla.	1989–2007	Basin is substantially urbanized.	None	No Baseline Period
41	07178000	Bird Creek near Owasso, Okla.	1936–1938, 1988–2007	Streamflow slightly regulated since 1958 by Bluestem Lake and since March 1977 by Birch Lake. Streamflow regulated since October 1984 by Skiatook Lake (capacity 322,300 acre-ft).	None	No Baseline Period
42	07178040	Mingo Creek at 46th Street North at Tulsa, Okla.	1988–1997	Basin is substantially urbanized.	None	No Baseline Period
43	07178200	Bird Creek at State Highway 266 near Catoosa, Okla.	1989–2007	Streamflow slightly regulated since 1958 by Bluestem Lake and since March 1977 by Birch Lake. Streamflow regulated since October 1984 by Skiatook Lake (capacity 322,300 acre-ft).	None	No Baseline Period
44	07184000	Lightning Creek near McCune, Kans.	1939–1946, 1960–2007	None	1939–1946, 1960–2007	Excellent
45	07185095	Tar Creek at 22nd Street Bridge at Miami, Okla.	1985–1993, 2005–2007	Basin is substantially urbanized.	None	No Baseline Period
46	07185500	Stahl Creek near Miller, Mo.	1951–1976	None	1951–1976	Excellent
47	07185700	Spring River at LaRussell, Mo.	1958–1973, 1976–1980	None	1958–1973, 1976–1980	Excellent
48	07185765	Spring River at Carthage, Mo.	1967–1980, 2002–2007	None	1967–1980, 2002–2007	Excellent

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49	07186000	Spring River near Waco, Mo.	1925–2007	Low flow affected by gristmills upstream.	1925–2007	Fair
50	07187000	Shoal Creek above Joplin, Mo.	1942–2007	None	1942–2007	Excellent
51	07188000	Spring River near Quapaw, Okla.	1940–2007	Streamflow is subject to periodic releases from floodgates at old Riverton hydroelectric plant, 15 miles upstream. Low flow may be slightly affected by Grand Falls Dam (low-water dam).	None	No Baseline Period
52	07188500	Lost Creek at Seneca, Mo.	1949–1959	None	1949–1959	Excellent
53	07189000	Elk River near Tiff City, Mo.	1940–2007	Backwater from Lake O' the Cherokees may affect streamflow when lake reaches upper range at flood pool.	1940–2007	Good
54	07189540	Cave Springs Branch near South West City, Mo.	1998–2007	None	1998–2007	Excellent
55	07189542	Honey Creek near South West City, Mo.	1998–2007	None	1998–2007	Excellent
56	07191000	Big Cabin Creek near Big Cabin, Okla.	1948–2007	Low flows are sustained to about 0.5 ft^3/s by effluent from the city of Vinita. Small amounts used for irrigation.	1948–2007	Fair
57	07191220	Spavinaw Creek near Sycamore, Okla.	1962–2007	None	1962–2007	Excellent
58	07192000	Pryor Creek near Pryor, Okla.	1948–1963	None	1948–1963	Excellent
59	07194800	Illinois River at Savoy, Ark.	1996–2007	Some regulation from floodwater-retarding structures.	1996–2007	Poor
60	07195000	Osage Creek near Elm Springs, Ark.	1951–1975, 1996–2007	Slight fluctuations during periods of low flow might be caused by operation of a small reservoir at the spring in the town of Cave Springs. Treated wastewater is discharged into Osage Creek by the City of Rogers Wastewater Pollution Control Facility about half a mile upstream from the Osage Creek. Treated wastewater also is discharged by the City of Springdale into Spring Creek, a tributary to Osage Creek that has a confluence just upstream from the confluence of Little Osage Creek. Occasionally, either plant will be shut down for servicing, resulting in noticeable drops in stage.	1951–1975, 1996–2007	Fair
61	07195430	Illinois River South of Siloam Springs, Ark.	1996–2006	None	1996–2006	Excellent

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Map number (fig. 1)	U.S. Geological Survey ID	Station name	Period of record (complete water years)	Comments[1]	Preliminary baseline period of record (complete water years)	Preliminary quality ranking[2]
62	07195500	Illinois River near Watts, Okla.	1956–2007	Since July 2, 1957, streamflow may be affected by small diversion for municipal water supply for the city of Siloam Springs, Arkansas, upstream from station. Some minor regulation during low flows by Lake Frances since 1931 until the dam was breached on May 4, 1990, by a high-flow event. Effects on streamflow prior to 1990 were considered negligible (only at low flow), and as of 2007 the low-water dam had no observable effect on streamflow.	1991–2007	Fair
63	07195800	Flint Creek at Springtown, Ark.	1962–2007	No known regulation or diversion except in 1964 and 1980 when pumpage for irrigation occurred upstream from station.	1962–1963, 1965–1979, 1981–2007	Good
64	07195855	Flint Creek near West Siloam Springs, Okla.	1980–2007	Streamflow regulated by Lake Siloam Springs and Little Flint Creek Reservoir, both about 4 miles upstream. Streamflow also is affected by treated wastewater discharge from the city of Gentry.	None	No Baseline Period
65	07195865	Sager Creek near West Siloam Springs, Okla.	1997–2007	Low flow sustained in part by treated wastewater effluent from Siloam Springs, Arkansas, 3 miles upstream from station.	1997–2007	Fair
66	07196000	Flint Creek near Kansas, Okla.	1956–1990, 1993–2007	Minor regulation by Lake Siloam Springs. Flow regulated by Little Flint Creek Reservoir since 1978. Small diversion upstream from station for irrigation.	1956–1977	Fair
67	07196500	Illinois River near Tahlequah, Okla.	1936–2007	None	1936–2007	Excellent
68	07196900	Baron Fork at Dutch Mills, Ark.	1959–2007	None	1959–2007	Excellent
69	07196973	Peacheater Creek at Christie, Okla.	1993–2003	None	1993–2003	Excellent
70	07197000	Baron Fork at Eldon, Okla.	1949–2007	None	1949–2007	Excellent
71	07197360	Caney Creek near Barber, Okla.	1998–2007	None	1998–2007	Excellent
72	07198000	Illinois River near Gore, Okla.	1925, 1940–2007	Streamflow completely regulated since July 1952 by Tenkiller Ferry Lake.	1925, 1940–1952	Excellent
73	07229300	Walnut Creek at Purcell, Okla.	1966–1993	Affected by backwater from Canadian River at times.	1966–1993	Excellent

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Map number (fig. 1)	U.S. Geological Survey ID	Station name	Period of record (complete water years)	Comments[1]	Preliminary baseline period of record (complete water years)	Preliminary quality ranking[2]
74	07230000	Little River below Lake Thunderbird near Norman, Okla.	1953–2007	Streamflow regulated by Lake Thunderbird since March 1965 (07229900). In prior years, occasional diversions upstream from station for irrigation.	1953–1964	Fair
75	07230500	Little River near Tecumseh, Okla.	1944–2007	Streamflow regulated or diverted since 1965 by Lake Thunderbird, 19.2 miles upstream. Small amount of pumped irrigation is used during the crop season.	1943–1964	Good
76	07231000	Little River near Sasakwa, Okla.	1943–2007	Streamflow regulated since 1962 by numerous floodwater-retarding structures. Streamflow regulated by Lake Thunderbird 80 miles upstream since March 1965.	1943–1961	Excellent
77	07232000	Gaines Creek near Krebs, Okla.	1943–1963	None	1943–1963	Excellent
78	07232500	Beaver River near Guymon, Okla.	1938–1993	Prior to 1972 considered a natural, unregulated basin. After 1978, irrigation development has had a substantial effect on streamflow.	1938–1971	Excellent
79	07232900	Coldwater Creek near Guymon, Okla.	1981–2007	After 1971, irrigation development has had a substantial effect on streamflow.	None	No Baseline Period
80	07233000	Coldwater Creek near Hardesty, Okla.	1940–1964	After 1971, irrigation development has had a substantial effect on streamflow.	1940–1964	Excellent
81	07233500	Palo Duro Creek near Spearman, Texas	1946–1979, 2000–2007	Small diversion upstream for irrigation. No streamflow at times. After 1971, irrigation development began in the region and has had a substantial effect on streamflow.	1946–1971	Good
82	07233650	Palo Duro Creek at Range, Okla.	1992–2007	Streamflow regulated for the period of record by Palo Duro Reservoir, 18 miles upstream. Streamflow also affected by local irrigation withdrawals since 1972.	None	No Baseline Period
83	07234100	Clear Creek near Elmwood, Okla.	1966–1993	Low flows sustained by nearby springs; streamflows affected by diversion ponds and occasional diversion for irrigation.	1966–1993	Poor
84	07235000	Wolf Creek at Lipscomb, Texas	1941–1942, 1962–2007	There are several small diversions upstream from station for irrigation and recreation. Since installation of the station, streamflow has been regulated by Lake Fryer, 30 miles upstream. After 1971, irrigation development has had a substantial effect on streamflow	None	No Baseline Period
85	07236000	Wolf Creek near Fargo, Okla.	1943–1976	Prior to 1972 considered an unregulated basin. After 1978, irrigation development began in the region and may also have had a substantial effect on streamflow. Minor regulation from Lake Fryer for period of record.	1943–1971	Fair
86	07237000	Wolf Creek near Fort Supply, Okla.	1938–1992	Streamflow completely regulated since May 1942 by Fort Supply Lake. After 1971, irrigation development has had a substantial effect on streamflow.	1938–1942	No Baseline Period

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Map number (fig. 1)	U.S. Geological Survey ID	Station name	Period of record (complete water years)	Comments[1]	Preliminary baseline period of record (complete water years)	Preliminary quality ranking[2]
87	07242350	Deep Fork near Arcadia, Okla.	1970–1993	Streamflow affected by urban watershed in the city of Oklahoma City, Okla. Regulated by Arcadia Dam since November 1986. Just prior to regulation, dam construction affected streamflow at times.	None	No Baseline Period
88	07242380	Deep Fork at Warwick, Okla.	1984–2007	Considerable regulation by Arcadia Lake, 30 miles upstream, since November 1986.	None	No Baseline Period
89	07243000	Dry Creek near Kendrick, Okla.	1956–1994	None	1956–1994	Excellent
90	07243500	Deep Fork near Beggs, Okla.	1939–2007	Streamflow regulated since 1968 by numerous floodwater-retarding structures. Some regulation by Arcadia Lake since November 1986.	1939–1967	Excellent
91	07244000	Deep Fork near Dewar, Okla.	1938–1950	Some small impoundments along tributaries, the largest of which is Lake Okmulgee.	1938–1950	Fair
92	07245500	Sallisaw Creek near Sallisaw, Okla.	1943–1976	Streamflow regulated since 1964 by numerous floodwater-retarding structures. Small diversion at low-water dam just upstream from station for municipal water supply for City of Sallisaw. During periods of extreme drought city pumps from pool just downstream from low-water dam.	1943–1963	Poor
93	07247000	Poteau River at Cauthron, Ark.	1940–2007	As of September 1974, streamflow from 92.2 mi^2 upstream from this station is controlled by 16 floodwater-detention reservoirs.	1940–1973	Excellent
94	07247015	Poteau River at Loving, Okla.	1993–2007	Regulation for period of record by numerous small floodwater-retarding structures.	None	No Baseline Period
95	07247250	Black Fork below Big Creek near Page, Okla.	1993–2007	None	1993–2007	Excellent
96	07247500	Fourche Maline near Red Oak, Okla.	1939–2007	Regulation since 1966 by floodwater-retarding structures.	1939–1965	Excellent
97	07248500	Poteau River near Wister, Okla.	1939–1986	Streamflow completely regulated since October 1949 by Wister Lake.	1939–1948	Excellent
98	07249400	James Fork near Hackett, Ark.	1959–2007	Strip mining activity upstream from station may affect streamflow.	1959–2007	Fair
99	07249413	Poteau River near Panama, Okla.	1993–2007	Streamflow regulated for period of record by Wister Reservoir, 34 miles upstream.	None	No Baseline Period
100	07249500	Cove Creek near Lee Creek, Ark.	1951–1970	None	1951–1970	Excellent

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Map number (fig. 1)	U.S. Geological Survey ID	Station name	Period of record (complete water years)	Comments[1]	Preliminary baseline period of record (complete water years)	Preliminary quality ranking[2]
101	07249985	Lee Creek near Short, Okla.	1931–1936, 1950–1991, 1993–2007	None	1931–1936, 1950–1991, 1993–2007	Excellent
102	07250000	Lee Creek near Van Buren, Ark.	1931–1936, 1951–1992	None	1931–1936, 1951–1992	Excellent
103	07300000	Salt Fork Red River near Wellington, Texas	1953–2007	Regulation since August 1967 by Greenbelt Reservoir (capacity 59,110 acre-ft) 42 miles upstream. One small diversion upstream for irrigation and diversions from Greenbelt Reservoir for municipal use by Greenbelt Municipal and Industrial Water Authority.	1953–1966	Fair
104	07300500	Salt Fork Red River at Mangum, Okla.	1938–2007	Streamflow regulated by Lake Greenbelt since 1967.	1938–1966	Excellent
105	07301110	Salt Fork Red River near Elmer, Okla.	1980–2007	Low flows sustained by irrigation returns from Lake Altus.	1980–2007	Poor
106	07301300	North Fork Red River near Shamrock, Texas	1965–1991, 2001–2007	Streamflow is partially regulated by McClellan Reservoir for the period of record. Streamflow also is affected at times by discharge from flood-detention pools of 11 floodwater-retarding structures.	None	No Baseline Period
107	07301410	Sweetwater Creek near Kelton, Texas	1963–2007	There are small diversions upstream from the station for ranch use.	1963–2007	Fair
108	07301420	Sweetwater Creek near Sweetwater, Okla.	1987–2007	None	1987–2007	Excellent
109	07301500	North Fork Red River near Carter, Okla.	1938–1962, 1965–2007	None	1938–1962, 1965–2007	Excellent
110	07303000	North Fork Red River below Altus Dam near Lugert, Okla.	1978–2007	Some regulation at low flow by Lugert Lake prior to December 1943, and completely regulated thereafter by Lake Altus for the period of record. Diversions at Lake Altus bypass most of streamflow.	None	No Baseline Period
111	07303400	Elm Fork of North Fork Red River near Carl, Okla.	1960–1979, 1995–2007	None	1960–1979, 1995–2007	Excellent
112	07303500	Elm Fork of North Fork Red River near Mangum, Okla.	1938–1976	Low flow is usually sustained by numerous springs upstream from station.	1938–1976	Excellent

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Map number (fig. 1)	U.S. Geological Survey ID	Station name	Period of record (complete water years)	Comments[1]	Preliminary baseline period of record (complete water years)	Preliminary quality ranking[2]
113	07304500	Elk Creek near Hobart, Okla.	1950–1993	Part of high streamflows are diverted 1 mile upstream from station, by means of a breech canal into Tom Steed Reservoir, since 1975. Several farms pump from the creek for irrigation upstream from the station.	1950–1974	Fair
114	07305500	West Otter Creek at Snyder Lake near Mountain Park, Okla.	1952–2003	Regulation by Snyder Lake from start of period of record through 1970, and regulation by Mountain Park Dam from 1971 through the completion of Tom Steed Reservoir. Flow completely regulated since June 1975 by Tom Steed Reservoir for the remainder of the period of record. The city of Snyder diverted about 130 acre-ft from Snyder Lake annually prior to October 1958 and none thereafter.	None	No Baseline Period
115	07307028	North Fork Red River near Tipton, Okla.	1985–2007	Streamflow regulated for period of record by storage and diversion at Lake Altus. Diversions for irrigation of about 48,000 acres upstream from station.	None	No Baseline Period
116	07311000	East Cache Creek near Walters, Okla.	1939–1963, 1970–2007	Low flow sustained by treated wastewater effluent from cities of Lawton and Walters. Minor regulation by Lake Lawtonka on Medicine Creek prior to late 1953, and additional minor regulation by Lake Thomas on Little Medicine Creek; regulation since March 1961 by Lake Ellsworth, on East Cache Creek.	1939–1960	No Baseline Period
117	07311200	Blue Beaver Creek near Cache, Okla.	1965–2003	Regulated by Lake Rush, Lake Jed Johnson, and Lake Ketch, for the period of record. Considered a "hydrologic benchmark" station.	None	No Baseline Period
118	07311500	Deep Red Creek near Randlett, Okla.	1950–1963, 1970–2007	Some regulation by numerous floodwater-retarding structures, and Lake Frederick.	1950–1963, 1970–2007	Poor
119	07313000	Little Beaver Creek near Duncan, Okla.	1949–1963	None	1949–1963	Excellent
120	07313500	Beaver Creek near Waurika, Okla.	1954–1993	Streamflow completely regulated by Waurika Lake (07313400) 1.2 miles upstream beginning August 1977.	1954–1976	Excellent
121	07315700	Mud Creek near Courtney, Okla.	1961–2007	Minor regulation from stock ponds.	1961–2007	Fair
122	07316500	Washita River near Cheyenne, Okla.	1938–2007	Streamflow regulated since 1961 by numerous floodwater-retarding structures. Several local irrigation wells in the alluvial plain along the right bank of the stream near the station may cause extreme low flows of 5 ft^3/s or less to drop off sharply during pumping, date of well construction is unknown.	1938–1960	Poor
123	07319500	Sandstone Creek near Berlin, Okla.	1953–1972	Streamflow is regulated for the period of record by numerous floodwater-retarding structures.	None	No Baseline Period
124	07323000	Sandstone Creek near Cheyenne, Okla.	1952–1973	Streamflow regulated for the period of record by numerous floodwater-retarding structures. Some diversion for irrigation upstream from station.	None	No Baseline Period

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125	07324200	Washita River near Hammon, Okla.	1970–1987, 1990–2007	Streamflow regulated for the period of record by numerous floodwater-retarding structures.	None	No Baseline Period
126	07324400	Washita River near Foss, Okla.	1962–1987, 1990–2007	Streamflow completely regulated for the period of record by Foss Reservoir.	None	No Baseline Period
127	07324500	Barnitz Creek near Arapaho, Okla.	1946–1963	Streamflow regulated since 1955 by numerous flood retention reservoirs.	1946–1954	No Baseline Period
128	07325000	Washita River near Clinton, Okla.	1936–2007	Streamflow regulated since February 1961 by Foss Reservoir (07324300) and by numerous floodwater-retarding structures.	1936–1960	Excellent
129	07325800	Cobb Creek near Eakly, Okla.	1969–2007	Streamflow regulated for the period of record by numerous floodwater-retarding structures.	None	No Baseline Period
130	07326000	Cobb Creek near Fort Cobb, Okla.	1940–2007	Streamflow regulated since March 1959 by Fort Cobb Reservoir.	1940–1958	Excellent
131	07326500	Washita River at Anadarko, Okla.	1964–2007	Streamflow regulated for the period of record by low-water dams upstream and by Fort Cobb Reservoir, Foss Reservoir, and numerous floodwater-retarding structures.	None	No Baseline Period
132	07327000	Sugar Creek near Gracemont, Okla.	1956–1974	Streamflow regulated since 1963 by numerous floodwater-retarding structures.	1956–1962	No Baseline Period
133	073274406	Little Washita River above Soil Conservation Service Pond 26 near Cyril, Okla.	1996–2007	None	1996–2007	Excellent
134	07327442	Little Washita River near Cyril, Okla.	1993–2007	Streamflow affected since 1971 by numerous flood retention reservoirs.	None	No Baseline Period
135	07327447	Little Washita River near Cement, Okla.	1993–2007	Streamflow regulated for the period of record by numerous flood retention reservoirs.	None	No Baseline Period
136	07327490	Little Washita River near Ninnekah, Okla.	1952–1985	Small diversions upstream from stations for irrigation. Statistical analyses include streamflow record from nearby station Little Washita River at Ninnekah, OK (07327500), October 1951 to September 1963. Flow regulated since 1974 by numerous floodwater-retarding structures.	1952–1973	Fair
137	07327550	Little Washita River East of Ninnekah, Okla.	1993–2007	Streamflow affected for the period of record by numerous flood retention reservoirs.	None	No Baseline Period

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Map number (fig. 1)	U.S. Geological Survey ID	Station name	Period of record (complete water years)	Comments[1]	Preliminary baseline period of record (complete water years)	Preliminary quality ranking[2]
138	07328070	Winter Creek near Alex, Okla.	1965–1986	Streamflow regulated since 1967 by 16 floodwater-retarding structures. Minor diversions for irrigation upstream from station.	None	No Baseline Period
139	07328180	North Criner Creek near Criner, Okla.	1990–2007	Streamflow regulated for the period of record by retention ponds 1.5 miles northwest of station.	None	No Baseline Period
140	07329000	Rush Creek at Purdy, Okla.	1940–1953, 1983–1994	Streamflow regulated since 1960 by numerous floodwater-retarding structures.	1940–1953	Excellent
141	07329500	Rush Creek near Maysville, Okla.	1955–1976	Streamflow regulated since 1960 by numerous floodwater-retarding structures.	1955–1959	No Baseline Period
142	07329700	Wildhorse Creek near Hoover, Okla.	1970–1993, 2001–2007	Streamflow regulated for the period of record by Duncan, Clear Creek, Humphries, and Fuqua Lakes, and numerous floodwater-retarding structures.	None	No Baseline Period
143	07329852	Rock Creek at Sulphur, Okla.	1990–2007	Streamflow regulated for the period of record by numerous floodwater-retarding structures.	None	No Baseline Period
144	07329900	Rock Creek at Dougherty, Okla.	1957–1966	Streamflow regulated since 1962 by numerous floodwater-retarding structures. Streamflow regulated by Lake Thunderbird 80 miles upstream since March 1965.	1957–1961	No Baseline Period
145	07330500	Caddo Creek near Ardmore, Okla.	1937–1950	Streamflow regulated since 1970 by numerous floodwater-retarding structures.	1937–1950	Excellent
146	07332400	Blue River at Milburn, Okla.	1966–1986	None	1966–1986	Excellent
147	07332500	Blue River near Blue, Okla.	1937–2007	Some regulation at low flow by a State fish hatchery, 16.0 miles upstream from station. Small diversion for municipal water supply for city of Durant, Oklahoma, water works dam about 14 miles upstream. Other diversons noted since 1981. No streamflow also on Sept. 19 to Oct. 16, 1956, as a result of regulation at fish hatchery.	1937–1980	Fair
148	07332600	Bois D'Arc Creek near Randolph, Texas	1964–1985	None	1964–1985	Excellent
149	07333500	Chickasaw Creek near Stringtown, Okla.	1956–1968	None	1956–1968	Excellent
150	07333800	McGee Creek near Stringtown, Okla.	1957–1968	None	1957–1968	Excellent

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Map number (fig. 1)	U.S. Geological Survey ID	Station name	Period of record (complete water years)	Comments[1]	Preliminary baseline period of record (complete water years)	Preliminary quality ranking[2]
151	07334000	Muddy Boggy Creek near Farris, Okla.	1938–2007	Some minor regulation since June 1959 by Atoka Reservoir; pipeline diversions from Atoka Reservoir to Oklahoma City since November 1963, and substantial regulation since April 1987 by McGee Creek Lake, drainage area 178 mi^2.	1938–1987	Poor
152	07335000	Clear Boggy Creek near Caney, Okla.	1943–1989, 2006–2007	Streamflow regulated since 1965 by numerous floodwater-retarding structures.	1943–1964	Excellent
153	07335300	Muddy Boggy Creek near Unger, Okla.	1983–2007	Streamflow is minorly regulated by Atoka Reservoir for the period of record, and substantially regulated by McGee Creek Reservoir since 1988. Streamflow also is minorly regulated by numerous floodwater-retarding structures for the period of record.	1983–1987	No Baseline Period
154	07335400	Sanders Creek near Chicota, Texas	1968–1986	Streamflow is regulated for the period of record by Pat Mayse Lake.	None	No Baseline Period
155	07335700	Kiamichi River near Big Cedar, Okla.	1966–2007	Hydrologic benchmark station.	1966–2007	Excellent
156	07335790	Kiamichi River near Clayton, Okla.	1982–2007	Regulation since December 1982 by Sardis Lake, on Jackfork Creek 4.5 miles upstream.	None	No Baseline Period
157	07336000	Tenmile Creek near Miller, Okla.	1956–1970	None	1956–1970	Excellent
158	07336200	Kiamichi River near Antlers, Okla.	1973–2007	Regulation since December 1982 by Sardis Lake, located on Jackfork Creek, 42 miles upstream from station. Small diversion for municipal water supply for city of Antlers upstream from station. Backwater from Hugo Reservoir may affect streamflow about 20 miles downstream from station.	1973–1982	Fair
159	07336500	Kiamichi River near Belzoni, Okla.	1926–1972	The City of Antlers, Oklahoma, diverts a small quantity of water, at a point upstream from the gaging station, for municipal use.	1926–1972	Fair
160	07336750	Little Pine Creek near Kanawha, Texas	1970–1980	None	1970–1980	Excellent
161	07336800	Pecan Bayou near Clarksville, Texas	1963–1977	None	1963–1977	Excellent
162	07337500	Little River near Wright City, Okla.	1945–1989	Except for 10 mi2 intervening area, streamflow completely regulated since June 1969 by Pine Creek Lake (07337300). On June 15, 1967, closure for diversion was made.	1945–1966	Excellent

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163	07337900	Glover River near Glover, Okla.	1962–2007	None	1962–2007	Excellent
164	07338500	Little River below Lukfata Creek near Idabel, Okla.	1930–2007	Streamflow regulated since June 1969 by Pine Creek Lake, 41.9 miles upstream. Substantial diversions by Weyerhaeuser Company 41 miles upstream from station, more than 1,500 acre-feet per month after completion of Pine Creek Lake. Prior to Pine Creek, water consumed by city of Idabel has some effect on low Streamflows.	1930–1968	Fair
165	07338750	Mountain Fork at Smithville, Okla.	1992–2007	None	1992–2007	Excellent
166	07339000	Mountain Fork near Eagletown, Okla.	1930–2007	Streamflow completely regulated except for 33-mi^2 intervening area, since October 1968 by Broken Bow Lake.	1930–1968	Excellent
167	07339500	Rolling Fork near DeQueen, Ark.	1949–1980	Regulation since Aug. 31, 1977, by DeQueen Lake.	1949–1976	Excellent
168	07340300	Cossatot River near Vandervoort, Ark.	1968–2007	None	1968–2007	Excellent
169	07340500	Cossatot River near DeQueen, Ark.	1939–1980	Regulation since May 1975 by Gillham Lake, 15.5 miles upstream.	1939–1974	Excellent
170	07341000	Saline River near Dierks, Ark.	1939–1980	Regulation and diversions since May 8, 1975, by Dierks Lake, 5.9 miles upstream.	1939–1974	Excellent
171	07341200	Saline River near Lockesburg, Ark.	1964–2007	Regulation since May 8, 1975, by Dierks Lake, 5.9 miles upstream for water supply for the City of Dierks.	1964–1974	Excellent

[1] Comments are from records at the Oklahoma Water Science Center, various U.S. Geological Survey reports (Tortorelli, 2002; Tortorelli, 2005), and from Robert L. Tortorelli, Robert L. Blazs, Tony Coffee, and David Adams, (U.S. Geological Survey, oral and written commun., 2008).

[2] Quality rank assigned for these preliminary baseline periods was changed in later analysis of the baseline period of record when the least–altered period of record was refined (table 7).

[3]Analysis includes streamflow record from nearby station (07174000) from 1939–1943.

Table 2. Preliminary least-altered period of record and quality ranking based on the years that the estimated area upstream from dams in the drainage basins of 115 streamflow-gaging stations in and near Oklahoma equaled or exceeded 1, 5, 10, or 20 percent of the drainage-basin area.

[No., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; %, percent; --, did not exceed indicated percentage; "no change" indicates that the baseline period of record did not change as a result of the assessment of impoundment; SCS, soil conservation service]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Period of record (complete water years[1])	Year during period of record in which the area upstream from dams equaled or exceeded a given percentage				Preliminary baseline period of record		Preliminary quality ranking	
				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
1	07148350	Salt Fork Arkansas River near Winchester, Okla.	1960–1993	1965	--	--	--	1960–1993	No change	Good	No change
2	07148400	Salt Fork Arkansas River near Alva, Okla.	1939–1951, 1980–2007	1961	--	--	--	1939–1951, 1980–2007	No change	Good	No change
3	07149000	Medicine Lodge River near Kiowa, Kans.	1939–1950, 1960–2007	before 1939	1969	--	--	1939–1950, 1959–2007	No change	Excellent	Fair
4	07149500	Salt Fork Arkansas River near Cherokee, Okla.	1941–1950	before 1941	--	--	--	1941–1950	No change	Excellent	Good
5	07151500	Chikaskia River near Corbin, Kans.	1951–1965, 1976–2007	1960	--	--	--	1951–1965, 1976–2007	No change	Good	Fair
6	07152000	Chikaskia River near Blackwell, Okla.	1937–2007	before 1937	--	--	--	1937–1949	1937–1949	Fair	No change
7	07153000	Black Bear Creek at Pawnee, Okla.	1945–2007	before 1945	before 1945	1961	1965	1945–1962	1945–1960	Fair	No change
9	07154500	Cimarron River near Kenton, Okla.	1951–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1951–2007	No change	Poor	No change
10	07155000	Cimarron River above Ute Creek near Boise City, Okla.	1943–1954	before 1943	--	--	--	1943–1954	No change	Poor	No change
12	07157500	Crooked Creek near Englewood, Kans.	1943–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1943–2007	No change	Poor	No change
13	07157900	Cavalry Creek at Coldwater, Kans.	1967–1980	Less than 1% of the drainage are was upstream from dams for the period of record				1967–1980	No change	Excellent	No change
14	07157960	Buffalo Creek near Lovedale, Okla.	1967–1993	before 1967	before 1967	1968	--	1967–1993	No change	Excellent	Poor
15	07158400	Salt Creek near Okeene, Okla.	1962–1967, 1975–1979	before 1962	--	--	--	1962–1967, 1975–1979	No change	Good	Fair

Table 2. Preliminary least-altered period of record and quality ranking based on the years that the estimated area upstream from dams in the drainage basins of 115 streamflow-gaging stations in and near Oklahoma equaled or exceeded 1, 5, 10, or 20 percent of the drainage-basin area.—Continued

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				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
16	07159000	Turkey Creek near Drummond, Okla.	1948–1970	before 1948	--	--	--	1948–1970	No change	Fair	Poor
19	07160500	Skeleton Creek near Lovell, Okla.	1950–1993, 2002–2007	before 1950	--	--	--	1950–1993, 2002–2007	No change	Excellent	Good
20	07163000	Council Creek near Stillwater, Okla.	1935–1993	Less than 1% of the drainage are was upstream from dams for the period of record				1934–1960	No change	Good	No change
25	07170700	Big Hill Creek near Cherryvale, Kans.	1958–2007	before 1958	1981	1981	1981	1958–1980	No change	Excellent	Good
26	07172000	Caney River near Elgin, Kans.	1940–2007	1960	1965	1966	1967	1940–1964	No change	Excellent	Good
27	07173000	Caney River near Hulah, Okla.	1938–1993	1947	1950	1950	1950	1938–1949	No change	Excellent	Good
28	07174200	Little Caney River below Cotton Creek, near Copan, Okla.	1939–1980	1963	1963	1964	1964	1939–1968	1939–1963	Excellent	No change
30	07174600	Sand Creek at Okesa, Okla.	1960–1993	1958	1958	1958		1960–1993	No change	Poor	No change
35	07176500	Bird Creek at Avant, Okla.	1946–2007	before 1946	1958	1958	1977	1946–1976	No change	Poor	No change
36	07176800	Candy Creek near Wolco, Okla.	1970–1980	Less than 1% of the drainage are was upstream from dams for the period of record				1970–1980	No change	Excellent	No change
37	07177000	Hominy Creek near Skiatook, Okla.	1945–1980	before 1945	--	--	--	1945–1980	No change	Excellent	Good
38	07177500	Bird Creek near Sperry, Okla.	1939–2007	1940	1958	1977	1984	1939–1957	No change	Fair	Good
44	07184000	Lightning Creek near McCune, Kans.	1939–1946, 1960–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1939–1946, 1960–2007	No change	Excellent	No change

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				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
46	07185500	Stahl Creek near Miller, Mo.	1951–1976	Less than 1% of the drainage are was upstream from dams for the period of record				1951–1976	No change	Excellent	No change
47	07185700	Spring River at LaRussell, Mo.	1958–1973, 1976–1980	Less than 1% of the drainage are was upstream from dams for the period of record				1958–1973, 1976–1980	No change	Excellent	No change
48	07185765	Spring River at Carthage, Mo.	1967–1980, 2002–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1967–1980, 2002–2007	No change	Excellent	No change
49	07186000	Spring River near Waco, Mo.	1925–2007	1955	--	--	--	1925–2007	No change	Fair	No change
50	07187000	Shoal Creek above Joplin, Mo.	1942–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1942–2007	No change	Excellent	No change
52	07188500	Lost Creek at Seneca, Mo.	1949–1959	Less than 1% of the drainage are was upstream from dams for the period of record				1949–1959	No change	Excellent	No change
53	07189000	Elk River near Tiff City, Mo.	1940–2007	1969	--	--	--	1940–2007	No change	Good	Fair
54	07189540	Cave Springs Branch near South West City, Mo.	1998–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1998–2007	No change	Excellent	No change
55	07189542	Honey Creek near South West City, Mo.	1998–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1998–2007	No change	Excellent	No change
56	07191000	Big Cabin Creek near Big Cabin, Okla.	1948–2007	before 1948	--	--	--	1948–2007	No change	Fair	Poor
57	07191220	Spavinaw Creek near Sycamore, Okla.	1962–2007	before 1962	--	--	--	1962–2007	No change	Excellent	Good

Table 2. Preliminary least-altered period of record and quality ranking based on the years that the estimated area upstream from dams in the drainage basins of 115 streamflow-gaging stations in and near Oklahoma equaled or exceeded 1, 5, 10, or 20 percent of the drainage-basin area.—Continued

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				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
58	07192000	Pryor Creek near Pryor, Okla.	1948–1963	Less than 1% of the drainage are was upstream from dams for the period of record				1948–1963	No change	Excellent	No change
59	07194800	Illinois River at Savoy, Ark.	1996–2007	before 1996	before 1996	before 1996	1996[3]	1996–2007	No Baseline Period	Poor	No Baseline Period
60	07195000	Osage Creek near Elm Springs, Ark.	1951–1975, 1996–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1951–1975, 1996–2007	No change	Fair	No change
61	07195430	Illinois River South of Siloam Springs, Ark.	1996–2006	before 1996	before 1996	before 1996[4]	--	1996–2006	No change	Excellent	Poor
62	07195500	Illinois River near Watts, Okla.	1956–2007	before 1956	1962	--	--	1991–2007	No change	Fair	No change
63	07195800	Flint Creek at Springtown, Ark.	1962–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1962–1963, 1965–1979, 1981–2007	No change	Good	No change
65	07195865	Sager Creek near West Siloam Springs, Okla.	1997–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1997–2007	No change	Fair	No change
66	07196000	Flint Creek near Kansas, Okla.	1956–1990, 1993–2007	before 1956	before 1956	1977	--	1956–1977	No change	Fair	No change
67	07196500	Illinois River near Tahlequah, Okla.	1936–2007	1943	1952	1978	--	1936–2007	1936–1977	Excellent	Fair
68	07196900	Baron Fork at Dutch Mills, Ark.	1959–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1959–2007	No change	Excellent	No change
69	07196973	Peacheater Creek at Christie, Okla.	1993–2003	Less than 1% of the drainage are was upstream from dams for the period of record				1993–2003	No change	Excellent	No change

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				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
70	07197000	Baron Fork at Eldon, Okla.	1949–2007	1967	--	--	--	1949–2007	No change	Excellent	Good
71	07197360	Caney Creek near Barber, Okla.	1998–2007	before 1998	--	--	--	1998–2007	No change	Excellent	Good
72	07198000	Illinois River near Gore, Okla.	1940–2007	1953	1953	1953	1953	1940–2007	1940–1951	Excellent	No change
73	07229300	Walnut Creek at Purcell, Okla.	1966–1993	before 1966	1968	--	--	1966–1993	No change	Excellent	Fair
74	07230000	Little River below Lake Thunderbird near Norman, Okla.	1953–2007	1950	1963	--	--	1953–1964	1953–1962	Fair	Poor
75	07230500	Little River near Tecumseh, Okla.	1944–2007	1960	1965	1965	1965	1943–1964	No change	Good	Fair
76	07231000	Little River near Sasakwa, Okla.	1943–2007	1957	1962	--	--	1943–1961	No change	Excellent	Good
78	07232500	Beaver River near Guymon, Okla.	1938–1993	1955	1955	1961	--	1938–1971	1938–1960	Excellent	Fair
80	07233000	Coldwater Creek near Hardesty, Okla.	1940–1964	Less than 1% of the drainage are was upstream from dams for the period of record				1940–1964	No change	Excellent	No change
81	07233500	Palo Duro Creek near Spearman, Texas	1946–1979, 2000–2007	1970	1970	1970	--	1946–1971	1946–1969	Good	No change
83	07234100	Clear Creek near Elmwood, Okla.	1966–1993	Less than 1% of the drainage are was upstream from dams for the period of record				1966–1993	No change	Poor	No change
85	07236000	Wolf Creek near Fargo, Okla.	1943–1976	before 1943	before 1943	before 1943	--	1943–1971	No change	Fair	Poor
89	07243000	Dry Creek near Kendrick, Okla.	1956–1994	1965	1998	--	--	1956–1994	No change	Excellent	Good
90	07243500	Deep Fork near Beggs, Okla.	1939–2007	1954	1961	1963	1978	1939–1967	1939–1960	Excellent	Good
91	07244000	Deep Fork near Dewar, Okla.	1938–1950	before 1938	1960	--	--	1938–1950	No change	Fair	Good
92	07245500	Sallisaw Creek near Sallisaw, Okla.	1943–1976	1963	1963	1963	1964	1943–1963	No change	Poor	No change

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				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
93	07247000	Poteau River at Cauthron, Ark.	1940–2007	1942	1964	1964	1969	1940–1973	1940–1963	Excellent	Good
95	07247250	Black Fork below Big Creek near Page, Okla.	1993–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1993–2007	No change	Excellent	No change
96	07247500	Fourche Maline near Red Oak, Okla.	1939–2007	before 1939	before 1939	1964	1964	1939–1965	1939–1963	Excellent	Fair
97	07248500	Poteau River near Wister, Okla.	1939–1986	1937	1949	1949	1949	1939–1948	No change	Excellent	Good
98	07249400	James Fork near Hackett, Ark.	1959–2007	before 1959	--	--	--	1959–2007	No change	Fair	No change
100	07249500	Cove Creek near Lee Creek, Ark.	1951–1970	Less than 1% of the drainage are was upstream from dams for the period of record				1951–1970	No change	Excellent	No change
101	07249985	Lee Creek near Short, Okla.	1931–1936, 1950–1991, 1993–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1931–1936, 1950–1991, 1993–2007	No change	Excellent	No change
102	07250000	Lee Creek near Van Buren, Ark.	1931–1936, 1951–1992	Less than 1% of the drainage are was upstream from dams for the period of record				1931–1936, 1951–1992	No change	Excellent	No change
103	07300000	Salt Fork Red River near Wellington, Texas	1953–2007	1967	1967	1967	1967	1953–1966	No change	Fair	No change
104	07300500	Salt Fork Red River at Mangum, Okla.	1938–2007	1967	1967	1967	1967	1938–1966	No change	Excellent	No change
105	07301110	Salt Fork Red River near Elmer, Okla.	1980–2007	before 1980	before 1980	before 1980	--	1980–2007	No Baseline Period[5]	Poor	No Baseline Period[5]
107	07301410	Sweetwater Creek near Kelton, Texas	1963–2007	before 1963	--	--	--	1963–2007	No change	Fair	No change
108	07301420	Sweetwater Creek near Sweetwater, Okla.	1987–2007	before 1987	--	--	--	1987–2007	No change	Excellent	Good

Table 2. Preliminary least-altered period of record and quality ranking based on the years that the estimated area upstream from dams in the drainage basins of 115 streamflow-gaging stations in and near Oklahoma equaled or exceeded 1, 5, 10, or 20 percent of the drainage-basin area.—Continued

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				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
109	07301500	North Fork Red River near Carter, Okla.	1938–1962, 1965–2007	1939	1964	1964	--	1938–1962, 1965–2007	1938–1962	Excellent	Fair
111	07303400	Elm Fork of North Fork Red River near Carl, Okla.	1960–1979, 1995–2007	1950	1950	1950	--	1960–1979, 1995–2007	No change	Excellent	Poor
112	07303500	Elm Fork of North Fork Red River near Mangum, Okla.	1938–1976	1950	1950	--	--	1938–1976	No change	Excellent	Fair
113	07304500	Elk Creek near Hobart, Okla.	1950–1993	before 1950	before 1950	before 1950	1969	1950–1974	1950–1966	Fair	Poor
118	07311500	Deep Red Creek near Randlett, Okla.	1950–1963, 1970–2007	1974	1974	1974	19986	1950–1963, 1970–2007	1950–1963, 1970–1973	Poor	Excellent
119	07313000	Little Beaver Creek near Duncan, Okla.	1949–1963	1960	--	--	--	1949–1963	No change	Excellent	Good
120	07313500	Beaver Creek near Waurika, Okla.	1954–1993	1960	1977	1977	1977	1954–1976	No change	Excellent	Good
121	07315700	Mud Creek near Courtney, Okla.	1961–2007	1960	--	--	--	1961–2007	No change	Fair	Good
122	07316500	Washita River near Cheyenne, Okla.	1938–2007	1958	1960	1961	1961	1938–1960	1938–1957	Poor	No change
128	07325000	Washita River near Clinton, Okla.	1936–2007	1952	1952	1956	1960	1936–1960	1936–1955	Excellent	Fair
130	07326000	Cobb Creek near Fort Cobb, Okla.	1940–2007	1956	1957	1959	1959	1940–1958	1940–1955	Excellent	No change
133	073274406	Little Washita River above SCS Pond 26 near Cyril, Okla.	1996–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1996–2007	No change	Excellent	No change
136	07327490	Little Washita River near Ninnekah, Okla.	1952–1985	1954	1960	1970	1972	1952–1973	1952–1969	Poor	No change
140	07329000	Rush Creek at Purdy, Okla.	1940–1953, 1983–1994	1950	1959	1960	1960	1940–1953	No change	Excellent	Good
145	07330500	Caddo Creek near Ardmore, Okla.	1937–1950	Less than 1% of the drainage are was upstream from dams for the period of record				1937–1950	No change	Excellent	No change

Table 2. Preliminary least-altered period of record and quality ranking based on the years that the estimated area upstream from dams in the drainage basins of 115 streamflow-gaging stations in and near Oklahoma equaled or exceeded 1, 5, 10, or 20 percent of the drainage-basin area.—Continued

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				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
146	07332400	Blue River at Milburn, Okla.	1966–1986	Less than 1% of the drainage are was upstream from dams for the period of record				1966–1986	No change	Excellent	No change
147	07332500	Blue River near Blue, Okla.	1937–2007	2000	2000	--	--	1937–1980	No change	Fair	No change
148	07332600	Bois D'Arc Creek near Randolph, Texas	1964–1985	Less than 1% of the drainage are was upstream from dams for the period of record				1964–1985	No change	Excellent	No change
149	07333500	Chickasaw Creek near Stringtown, Okla.	1956–1968	Less than 1% of the drainage are was upstream from dams for the period of record				1956–1968	No change	Excellent	No change
150	07333800	McGee Creek near Stringtown, Okla.	1957–1968	Less than 1% of the drainage are was upstream from dams for the period of record				1957–1968	No change	Excellent	No change
151	07334000	Muddy Boggy Creek near Farris, Okla.	1938–2007	1959	1959	1959	1982	1938–1987	No change	Poor	Excellent
152	07335000	Clear Boggy Creek near Caney, Okla.	1943–1989, 2006–2007	1950	1961	1962	1965	1943–1964	1943–1960	Excellent	Good
155	07335700	Kiamichi River near Big Cedar, Okla.	1966–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1966–2007	No change	Excellent	No change
157	07336000	Tenmile Creek near Miller, Okla.	1956–1970	Less than 1% of the drainage are was upstream from dams for the period of record				1956–1970	No change	Excellent	No change
158	07336200	Kiamichi River near Antlers, Okla.	1973–2007	1959	1983	1983	1983	1973–1982	No change	Fair	No change
159	07336500	Kiamichi River near Belzoni, Okla.	1926–1972	1964	--	--	--	1926–1972	No change	Fair	No change
160	07336750	Little Pine Creek near Kanawha, Texas	1970–1980	Less than 1% of the drainage are was upstream from dams for the period of record				1970–1980	No change	Excellent	Excellent

Table 2. Preliminary least-altered period of record and quality ranking based on the years that the estimated area upstream from dams in the drainage basins of 115 streamflow-gaging stations in and near Oklahoma equaled or exceeded 1, 5, 10, or 20 percent of the drainage-basin area.—Continued

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				1%	5%	10%	20%	Prior to assessment[2]	Adjusted from assessment[2]	Prior to assessment[2]	Adjusted from assessment[2]
161	07336800	Pecan Bayou near Clarksville, Texas	1963–1977	before 1963	--	--	--	1963–1977	No change	Excellent	Good
162	07337500	Little River near Wright City, Okla.	1945–1989	1969	1969	1969	1969	1945–1966	No change	Excellent	No change
163	07337900	Glover River near Glover, Okla.	1962–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1962–2007	No change	Excellent	No change
164	07338500	Little River below Lukfata Creek, near Idabel, Okla.	1930–2007	1969	1969	1969	1969	1930–1968	No change	Fair	No change
165	07338750	Mountain Fork at Smithville, Okla.	1992–2007	before 1992	before 1992	--	--	1992–2007	No change	Excellent	Fair
166	07339000	Mountain Fork near Eagletown, Okla.	1930–2007	1957	1969	1969	1969	1930–1968	No change	Excellent	Good
167	07339500	Rolling Fork near DeQueen, Ark.	1949–1980	1977	1977	1977	1977	1949–1976	No change	Excellent	No change
168	07340300	Cossatot River near Vandervoort, Ark.	1968–2007	Less than 1% of the drainage are was upstream from dams for the period of record				1968–2007	1968–2007	Excellent	No change
169	07340500	Cossatot River near DeQueen, Ark.	1939–1980	1969	1975	1975	1975	1939–1974	No change	Excellent	Good
170	07341000	Saline River near Dierks, Ark.	1939–1980	1975	1975	1975	1975	1939–1974	No change	Excellent	No change
171	07341200	Saline River near Lockesburg, Ark.	1964–2007	1975	1975	1975	1975	1964–1974	No change	Excellent	No change

[1] Complete water years are those years where daily discharge data are available for every day of the Water Year, October 1 through September 30.

[2] In previous analysis, the preliminary baseline period and quality ranking was determined from historical basin information only. In the analysis of impoundment presented in this table, the preliminary baseline period was adjusted to eliminate those years after a substantial increase in impoundment in the drainage basin and quality ranking was adjusted based on the percentage of the drainage area upstream from impoundments for the remaining years.

[3] In 1996, the estimated percentage of the drainage area upstream from impoundment was just under 20%.

[4] In 1996, the estimated percentage of the drainage area upstream from impoundment was just under 10%.

[5] The ranking for this station was downgraded to "no baseline period" because more than 15 percent of the drainage basin was affected by regulation for the period of streamflow record and historical station notes indicated that streamflow was affected by irrigation returns.

[6] In 1998, the estimated percentage of the drainage area upstream from impoundment was just under 20%.

Table 3. Results and description of visual trends in annual base flow, runoff, total flow, and base-flow index, for the entire period of record for 74 streamflow-gaging stations in and near Oklahoma with at least 20 years of available record.

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; base-flow index is the ratio of base flow to total flow]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Period of record (water rears)[1]	Period of record analyzed (water years)[1]	Number of years analyzed	Was trend in annual plot over time visually obvious?				Remarks	Was further analysis conducted?[2]
						Base flow	Runoff	Total flow	Base-flow index		
1	07148350	Salt Fork Arkansas River near Winchester, Okla.	1960–1993	1960–1993	34	Yes, upward	No	Yes, upward	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
2	07148400	Salt Fork Arkansas River near Alva, Okla.	1939–1951, 1980–2007	1939–1951[3]	13	Yes, upward	Yes, downward	No	Yes, upward	Upward visual trends in base flow and base-flow index appear to start in the early 1980s. Assumption made that observed upward trend is associated with climate. Downward trends in runoff do not follow these assumptions, however.	No[3]
3	07149000	Medicine Lodge River near Kiowa, Kans.	1938–1950, 1959–2007	1938–1950, 1959–2007	70	Yes, upward	No	Yes, upward	Yes, upward	Trends observed prior to the 1980s.	Yes
5	07151500	Chikaskia River near Corbin, Kans.	1951–1965, 1976–2007	1951–1965, 1976–2007	57	Yes, upward	No	No	No	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
6	07152000	Chikaskia River near Blackwell, Okla.	1937–2007	1937–2007	71	Yes, upward	No	No	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
9	07154500	Cimarron River near Kenton, Okla.	1951–2007	1951–2007	57	Yes, downward	Yes, downward	Yes, downward	No		Yes
12	07157500	Crooked Creek near Englewood, Kans.	1943–2007	1943–2007	65	No	Yes, downward	Yes, downward	Yes, upward		Yes
14	07157960	Buffalo Creek near Lovedale, Okla.	1966–1993	1966–1993	28	Yes, upward	No	No	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
16	07159000	Turkey Creek near Drummond, Okla.	1948–1970	1948–1970	23	No	No	No	No		No
19	07160500	Skeleton Creek near Lovell, Okla.	1950–1993, 2002–2007	1950–1993, 2002–2007	58	Yes, upward	No	No	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
20	07163000	Council Creek near Stillwater, Okla.	1935–1993	1935–1960	26	Yes, upward	No	No	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No

Table 3. Results and description of visual trends in annual base flow, runoff, total flow, and base-flow index, for the entire period of record for 74 streamflow-gaging stations in and near Oklahoma with at least 20 years of available record.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; base-flow index is the ratio of base flow to total flow]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Period of record (water rears)[1]	Period of record analyzed (water years)[1]	Number of years analyzed	Was trend in annual plot over time visually obvious?				Remarks	Was further analysis conducted?[2]
						Base flow	Runoff	Total flow	Base-flow index		
25	07170700	Big Hill Creek near Cherryvale, Kans.	1958–2007	1958–1980	23	No	No	No	No		No
26	07172000	Caney River near Elgin, Kans.	1940–2007	1940–1964	25	No	No	No	No		No
28	07174200	Little Caney River below Cotton Creek, near Copan, Okla.	1944–1980	1944–1968	25	No	No	No	No		No
30	07174600	Sand Creek at Okesa, Okla.	1960–1993	1960–1993	34	Yes, upward	Yes, upward	Yes, upward	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
35	07176500	Bird Creek at Avant, Okla.	1946–2007	1946–1976	31	Yes, upward	Yes, upward	Yes, upward	Yes, upward	Trends observed prior to the 1980s.	Yes
37	07177000	Hominy Creek near Skiatook, Okla.	1945–1980	1945–1980	36	No	No	No	No		No
44	07184000	Lightning Creek near McCune, Kans.	1939–1946, 1960–2007	1939–1946, 1960–2007	69	No	No	No	No		No
46	07185500	Stahl Creek near Miller, Mo.	1951–1976	1951–1976	26	No	Yes, upward	Yes, upward	Yes, upward	Trends observed prior to the 1980s.	Yes
47	07185700	Spring River at LaRussell, Mo.	1958–1973, 1976–1980	1958–1973, 1976–1980	23	No	No	No	Yes, downward	Trend in base-flow index appears to start prior to the 1980s.	Yes
48	07185765	Spring River at Carthage, Mo.	1967–1980, 2002–2007	1967–1980, 2002–2007	41	No	No	No	No	Trends are difficult to observe because of large gap in period of record.	No
49	07186000	Spring River near Waco, Mo.	1925–2007	1925–2007	83	No	No	No	No		No
50	07187000	Shoal Creek above Joplin, Mo.	1942–2007	1942–2007	66	No	No	No	No		No
53	07189000	Elk River near Tiff City, Mo.	1940–2007	1940–2007	68	No	No	No	No		No
56	07191000	Big Cabin Creek near Big Cabin, Okla.	1948–2007	1948–2007	60	No	No	No	No		No
57	07191220	Spavinaw Creek near Sycamore, Okla.	1962–2007	1962–2007	46	No	No	No	No		No

Table 3. Results and description of visual trends in annual base flow, runoff, total flow, and base-flow index, for the entire period of record for 74 streamflow-gaging stations in and near Oklahoma with at least 20 years of available record.—Continued

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Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Period of record (water rears)[1]	Period of record analyzed (water years)[1]	Number of years analyzed	Was trend in annual plot over time visually obvious?				Remarks	Was further analysis conducted?[2]
						Base flow	Runoff	Total flow	Base-flow index		
60	07195000	Osage Creek near Elm Springs, Ark.	1951–1975, 1996–2007	1951–1975, 1996–2007	57	No	No	No	No		No
63	07195800	Flint Creek at Springtown, Ark.	1962–2007	1962–1963, 1965–1979, 1981–2007	46	No	No	No	No		No
66	07196000	Flint Creek near Kansas, Okla.	1956–1990, 1993–2007	1956–1977	22	No	No	No	No		No
67	07196500	Illinois River near Tahlequah, Okla.	1936–2007	1936–2007	72	No	No	No	No		No
68	07196900	Baron Fork at Dutch Mills, Ark.	1959–2007	1959–2007	49	No	No	No	No		No
70	07197000	Baron Fork at Eldon, Okla.	1949–2007	1949–2007	59	No	No	No	No		No
73	07229300	Walnut Creek at Purcell, Okla.	1966–1993	1966–1993	28	Yes, upward	Yes, upward	Yes, upward	No	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
77	07232000	Gaines Creek near Krebs, Okla.	1943–1963	1943–1963	21	No	No	No	No		No
78	07232500	Beaver River near Guymon, Okla.	1938–1993	1938–1971	34	No	No	No	No		No
80	07233000	Coldwater Creek near Hardesty, Okla.	1940–1964	1940–1964	25	No	No	No	No		No
81	07233500	Palo Duro Creek near Spearman, Texas	1946–1979, 2000–2007	1946–1971	26	No	No	No	No		No
83	07234100	Clear Creek near Elmwood, Okla.	1966–1993	1966–1993	28	No	Yes, downward	Yes, downward	Yes, upward	Upward visual trends in base-flow index and decreases in runoff and total flow appear to start prior to the 1980s.	Yes
85	07236000	Wolf Creek near Fargo, Okla.	1943–1976	1943–1971	29	Yes, downward	Yes, downward	Yes, downward	Yes, upward	Trends prior to irrigation period of record established by Wahl and Tortorelli (1997).	Yes
89	07243000	Dry Creek near Kendrick, Okla.	1956–1994	1956–1994	39	Yes, upward	Yes, upward	Yes, upward	No	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
90	07243500	Deep Fork near Beggs, Okla.	1939–2007	1939–1967	29	No	No	No	No		No

Table 3. Results and description of visual trends in annual base flow, runoff, total flow, and base-flow index, for the entire period of record for 74 streamflow-gaging stations in and near Oklahoma with at least 20 years of available record.—Continued

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Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Period of record (water rears)[1]	Period of record analyzed (water years)[1]	Number of years analyzed	Was trend in annual plot over time visually obvious?				Remarks	Was further analysis conducted?[2]
						Base flow	Runoff	Total flow	Base-flow index		
92	07245500	Sallisaw Creek near Sallisaw, Okla.	1943–1976	1943–1963	21	No	No	No	No		No
93	07247000	Poteau River at Cauthron, Ark.	1940–2007	1940–1973	34	Yes, upward	No	No	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
96	07247500	Fourche Maline near Red Oak, Okla.	1939–2007	1939–1965	27	No	No	No	No		No
98	07249400	James Fork near Hackett, Ark.	1959–2007	1959–2007	49	No	No	No	Yes, downward	Downward trend in base-flow index appear to start in the late 1980s. Assumption made that observed trend is associated with climate.	No
101	07249985	Lee Creek near Short, Okla.	1931–1936, 1950–1991, 1993–2007	1931–1936, 1950–1991, 1993–2007	77	No	No	No	Yes, downward	Downward visual trend in base-flow index appear to start in the late 1980s. Assumption made that observed trend is associated with climate.	No
102	07250000	Lee Creek near Van Buren, Ark.	1931–1936, 1951–1992	1931–1936, 1951–1992	62	Yes, upward	No	Yes, upward	No	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
104	07300500	Salt Fork Red River at Mangum, Okla.	1938–2007	1938–1966	29	Yes, upward	Yes, downward	No	Yes, upward	Upward visual trends in base flow and base-flow index appear to start in the early 1980s. Assumption made that observed upwards trend is associated with climate. Downward visual trends in runoff do not follow these assumptions, however.	Yes
107	07301410	Sweetwater Creek near Kelton, Texas	1963–2007	1963–2007	45	No	No	Yes, downward	Yes, upward	Upward visual trends in base-flow index appear to start in the early 1980s. Assumption made that observed trend is associated with climate. Downward visual trend in total flow do not follow these assumptions, however.	Yes
108	07301420	Sweetwater Creek near Sweetwater, Okla.	1987–2007	1987–2007	21	No	No	No	Yes, downward	Downward visual trend in base-flow index appear to start after 2000 (end of a wet period). Assumption made that observed trend is associated with climate.	No
109	07301500	North Fork Red River near Carter, Okla.	1938–1962, 1965–2007	1938–1962, 1965–2007	70	Yes, upward	Yes, downward	No	Yes, upward	Upward visual trend in base-flow index appears to start prior to the 1980s. Other visual trends are downward even during the wet period.	Yes

Table 3. Results and description of visual trends in annual base flow, runoff, total flow, and base-flow index, for the entire period of record for 74 streamflow-gaging stations in and near Oklahoma with at least 20 years of available record.—Continued

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Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Period of record (water rears)[1]	Period of record analyzed (water years)[1]	Number of years analyzed	Was trend in annual plot over time visually obvious?				Remarks	Was further analysis conducted?[2]
						Base flow	Runoff	Total flow	Base-flow index		
111	07303400	Elm Fork of North Fork Red River near Carl, Okla.	1960–1979, 1995–2007	1960–1979, 1995–2007	48	No	No	No	No	Trends are difficult to observe because of large gap in period of record.	No
112	07303500	Elm Fork of North Fork Red River near Mangum, Okla.	1938–1976	1938–1976	39	No	No	No	No	Trends are difficult to observe because of large gap in period of record.	No
113	07304500	Elk Creek near Hobart, Okla.	1950–1993	1950–1974	25	Yes, upward	No	No	Yes, upward	Upward visual trends appear to start in the early to mid 1980s. Assumption made that observed trend is associated with climate.	No
118	07311500	Deep Red Creek near Randlett, Okla.	1950–1963, 1970–2007	1950–1963, 1970–2007	58	Yes, upward	Yes, upward	Yes, upward	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
120	07313500	Beaver Creek near Waurika, Okla.	1954–1993	1954–1976	23	No	No	No	No		No
121	07315700	Mud Creek near Courtney, Okla.	1961–2007	1961–2007	47	Yes, upward	Yes, upward	Yes, upward	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
122	07316500	Washita River near Cheyenne, Okla.	1938–2007	1938–1960	23	No	No	No	No		No
128	07325000	Washita River near Clinton, Okla.	1936–2007	1936–1960	25	No	No	No	No		No
136	07327490	Little Washita River near Ninnekah, Okla.	1952–1985	1952–1973	22	No	Yes, upward	No	No	Upward visual trends in base-flow index appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
146	07332400	Blue River at Milburn, Okla.	1966–1986	1966–1986	21	No	No	No	No		No
147	07332500	Blue River near Blue, Okla.	1937–2007	1937–1980	44	No	No	No	No		No
148	07332600	Bois D'Arc Creek near Randolph, Texas	1964–1985	1964–1985	22	No	No	No	No		No
151	07334000	Muddy Boggy Creek near Farris, Okla.	1938–2007	1938–1987	50	No	No	No	No		No

Table 3. Results and description of visual trends in annual base flow, runoff, total flow, and base-flow index, for the entire period of record for 74 streamflow-gaging stations in and near Oklahoma with at least 20 years of available record.—Continued

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Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Period of record (water rears)[1]	Period of record analyzed (water years)[1]	Number of years analyzed	Was trend in annual plot over time visually obvious?				Remarks	Was further analysis conducted?[2]
						Base flow	Runoff	Total flow	Base-flow index		
155	07335700	Kiamichi River near Big Cedar, Okla.	1966–2007	1966–2007	42	No	No	No	No		No
159	07336500	Kiamichi River near Belzoni, Okla.	1926–1972	1926–1972	47	No	No	No	No		No
162	07337500	Little River near Wright City, Okla.	1945–1989	1945–1966	22	No	No	No	No		No
163	07337900	Glover River near Glover, Okla.	1962–2007	1962–2007	46	No	No	No	No		No
164	07338500	Little River blw Lukfata Ck, near Idabel, Okla.	1930–2007	1930–1968	39	No	No	No	No		No
166	07339000	Mountain Fork near Eagletown, Okla.	1930–2007	1930–1967	38	No	No	No	No		No
167	07339500	Rolling Fork near DeQueen, Ark.	1949–1980	1949–1976	28	No	No	No	No		No
168	07340300	Cossatot River near Vandervoort, Ark.	1968–2007	1968–2007	40	Yes, upward	Yes, upward	Yes, upward	No	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
169	07340500	Cossatot River near DeQueen, Ark.	1939–1980	1939–1974	36	Yes, upward	No	No	Yes, upward	Upward visual trends appear to start in the early 1980s. Assumption made that observed trend is associated with climate.	No
170	07341000	Saline River near Dierks, Ark.	1939–1980	1939–1974	36	No	No	No	No		No

[1] Record was only analyzed if 20 or more years were available prior to the start of substantial regulation, which is defined as the year when 20 percent or more of the basin was regulated by water-supply or flood-control dams (table 1).

[2] If there were visually observed trends that were not attributable to changes in climate (increases at the start of the wet period in the early 1980s, for example), then a Kendall's tau trend test was performed for the annual parameter during the period of record. Results for those sites where further analysis was performed are listed in table 4.

[3] Double mass and Kendall's tau could not be used to analyze the full dataset because of the gap in the period of record. The earlier period, 1939–1951, should be considered baseline based on visual analysis alone.

Table 4. Selected results of analysis of covariance test for double-mass curves for annual streamflow data at 11 selected streamflow-gaging stations and annual precipitation data at selected climate divisions in and near Oklahoma.

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; No BP identified, no significant breakpoints were detected on the double-mass curve; --, did not calculate because there was no breakpoint identified; <, less than]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Climate division	Period of record (water years)	Period of record tested[1]	Flow type	Selected breakpoint years	P-value	F-value	Is F-value the maximum for the F-test dataset?	Direction of trend with respect to precipitation	Remark	Was Kendall's tau analysis conducted for this parameter and breakpoint year?[2]	If yes, least-altered period of record(s) tested
3	07149000	Medicine Lodge River near Kiowa, Kans.	KS8	1939–1950, 1960–2007	1939–1950, 1960–2007	Base flow	1982	<0.0001	24.1	Yes	Upward	Many breakpoints on curve (gradual upward trend). Probably associated with start of wet period.	No	--
						Base flow	1970	<.0001	22	No	Upward	Many breakpoints on curve (gradual upward trend). Visually prominent.	Yes	1939–1969; 1971–2007; 1939–2007
						Runoff	2000	.029	5.26	Yes	Downward	Isolated breakpoint. Probably associated with end of wet period.	No	--
						Total flow	No BP identified	--			--	--	No	--
9	07154500	Cimarron River near Kenton, Okla.	OK1	1951–2007	1951–2007	Base flow	1971	<.0001	25	Yes	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1951–1966; 1972–2007; 1951–2007
						Runoff	1968	<.0001	14.2	Yes	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1951–1966; 1972–2007; 1951–2007
						Total flow	1968	<.0001	15.2	Yes	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1951–1966; 1972–2007; 1951–2007
12	07157500	Crooked Creek near Englewood, Kans.	KS7	1943–2007	1943–2007	Base flow	1976	.001	12.7	Yes	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1943–1975; 1977–2007; 1943–2007
						Runoff	1956	<.0001	27.6	Yes	Downward	Many breakpoints on curve (gradual downward trend). Not enough years to run double-mass analysis.	No	
						Runoff	1964	<.0001	22.5	No	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1943–1963; 1965–2007; 1943–2007
						Total flow	1956	<.0001	25.1	Yes	Downward	Many breakpoints on curve (gradual downward trend). Not enough years to run double-mass analysis.	No	
						Total flow	1964	<.0001	19.6	No	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1943–1963; 1965–2007; 1943–2007

Table 4. Selected results of analysis of covariance test for double-mass curves for annual streamflow data at 11 selected streamflow-gaging stations and annual precipitation data at selected climate divisions in and near Oklahoma.—Continued

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Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Climate division	Period of record (water years)	Period of record tested[1]	Flow type	Selected breakpoint years	P-value	F-value	Is F-value the maximum for the F-test dataset?	Direction of trend with respect to precipitation	Remark	Was Kendall's tau analysis conducted for this parameter and breakpoint year?[2]	If yes, least-altered period of record(s) tested
35	07176500	Bird Creek at Avant, Okla.	OK3	1946–2007	1946–1976	Base flow	1968	0.041	4.61	No	Upward	A few other breakpoints on curve. Visually prominent.	Yes	1946–1967; 1946–1976
						Base flow	1973	.009	7.93	Yes	Upward	A few other breakpoints on curve.	Yes	1946–1972
						Runoff	No BP identified	--			--	--	No	--
						Total flow	No BP identified	--			--	--	No	--
46	07185500	Stahl Creek near Miller, Mo.	MO4	1951–1976	1951–1976	Base flow	No BP identified	--			--	--	No	--
						Runoff	No BP identified	--			--	--	No	--
						Total flow	No BP identified	--			--	--	No	--
47	07185700	Spring River at LaRussell, Mo.	MO4	1958–1973, 1976–1980	1958–1973, 1976–1980	Base flow	No BP identified	--			--	--	No	--
						Runoff	No BP identified	--			--	--	No	--
						Total flow	No BP identified	--			--	--	No	--
83	07234100	Clear Creek near Elmwood, Okla.	OK1	1966–1993	1966–1993	Base flow	No BP identified	--			--	--	No	--
						Runoff	1974	<.0001	22.8	Yes	Downward	A few other breakpoints on curve.	Yes	1966–1993; 1975–1993
						Total flow	1974	<.0001	21.8	Yes	Downward	A few other breakpoints on curve.	Yes	1966–1993; 1975–1993

Table 4. Selected results of analysis of covariance test for double-mass curves for annual streamflow data at 11 selected streamflow-gaging stations and annual precipitation data at selected climate divisions in and near Oklahoma.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; No BP identified, no significant breakpoints were detected on the double-mass curve; --, did not calculate because there was no breakpoint identified; <, less than]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Climate division	Period of record (water years)	Period of record tested[1]	Flow type	Selected breakpoint years	P-value	F-value	Is F-value the maximum for the F-test dataset?	Direction of trend with respect to precipitation	Remark	Was Kendall's tau analysis conducted for this parameter and breakpoint year?[2]	If yes, least-altered period of record(s) tested
85	07236000	Wolf Creek near Fargo, Okla.	OK1	1943–1976	1943–1976	Base flow	1953	0.005	12.6	Yes	Downward	A few other breakpoints on curve. Not enough record in period to run a Kendall's tau test.	No	--
						Base flow	1957	.045	4.35	No	Downward	A few other breakpoints on curve. Visually prominent when compared to other years, but a weak breakpoint. Only 14 years in period prior to breakpoint.[3]	Yes[3, 4]	1943–1956; 1960–1976; 1943–1976
						Runoff	1959	.000	13.6	Yes	Downward	A few other breakpoints on curve.	Yes[3, 4]	1943–1956; 1960–1976; 1943–1976
						Total flow	1958	.001	11.1	Yes	Downward	A few other breakpoints on curve.	Yes[3, 4]	1943–1956; 1960–1976; 1943–1976
104	07300500	Salt Fork Red River at Mangum, Okla.	OK7	1938–2007	1938–1966	Base flow	1957	.011	7.5	Yes	Upward	A few other breakpoints on curve.	Yes	1938–1957; 1938–1966
						Runoff	No BP identified	--			--	--	No	
						Total flow	No BP identified	--			--	--	No	
107	07301410	Sweetwater Creek near Kelton, Texas	TX2	1963–2007	1963–2007	Base flow	No BP identified	--			--	--	No	
						Runoff	1980	.001	14.3	Yes	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1963–1980; 1981–2007; 1963–2007
						Total flow	1979	.023	6.7	Yes	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1963–1979; 1981–2007; 1963–2007

Table 4. Selected results of analysis of covariance test for double-mass curves for annual streamflow data at 11 selected streamflow-gaging stations and annual precipitation data at selected climate divisions in and near Oklahoma.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; No BP identified, no significant breakpoints were detected on the double-mass curve; --, did not calculate because there was no breakpoint identified; <, less than]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Climate division	Period of record (water years)	Period of record tested[1]	Flow type	Selected breakpoint years	P-value	F-value	Is F-value the maximum for the F-test dataset?	Direction of trend with respect to precipitation	Remark	Was Kendall's tau analysis conducted for this parameter and breakpoint year?[2]	If yes, least-altered period of record(s) tested
109	07301500	North Fork Red River near Carter, Okla.	OK4	1938–1962, 1965–2007	1938–1962, 1965–2007	Base flow	1987	<0.0001	33.8	Yes	Upward	Many breakpoints on curve (gradual upward trend). Probably associated with the wet period.	No	
						Base flow	1960	.008	7.38	No	Upward	Many breakpoints on curve (gradual upward trend). Visually prominent, but also may be because of gap in the record.	Yes	1938–1961; 1965–2007
						Runoff	1965	<.0001	30.6	Yes	Downward	Many breakpoints on curve (gradual downward trend). May be because of gap in the record.	Yes	1938–1961; 1965–2007; 1938–1962, 1965–2007
						Total flow	1952	.002	10.6	Yes	Downward	Many breakpoints on curve (gradual downward trend).	Yes	1938–1952; 1953–1962; 1965–2007; 1938–1962, 1965–2007
						Total flow	1965	.002	10.5	No	Downward	Many breakpoints on curve (gradual downward trend). May be because of gap in the record.	Yes	1938–1961; 1965–2007; 1938–1962, 1965–2007

[1] If there was obvious or complete regulation, such as a dam that affected streamflow from a substantial part of the drainage basin, then only that period was analyzed by using double-mass analysis.

[2] Kendall's tau test was run on sub-periods of at least 15 years unless indicated otherwise.

[3] An exception was made and the record 1943–1956 was analyzed by using a Kendall's tau test even though 14 years is a short period.

[4] Even though the breakpoints with the highest F-value for annual base flow, annual runoff, and annual total flow varied between 1957 and 1959, common sub-periods of 1943–1956 and 1960–1976 were tested for consistency.

Table 5. Results of Kendall's tau trend test of selected annual flow parameters for nine selected streamflow-gaging stations in and near Oklahoma.

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; --, trend slope was not calculated because the trend was not statistically significant at a critical p-value of 0.05; <, less than; "no change" indicates that the baseline period of record or quality rank of the baseline period did not change as a result of the trend assessment]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Streamflow parameter	Period tested (water years)	Kendall's tau results: Kendall's tau	Kendall's tau results: Probability value	Trend slope (units per year)	Trend slope (percent of median for period tested, per year)	Preliminary baseline period of record: Prior to trend analysis	Preliminary baseline period of record: Adjusted from trend analysis	Preliminary quality rank: Prior to trend analysis	Preliminary quality rank: Adjusted from trend analysis
3	07149000	Medicine Lodge River near Kiowa, Kans.	Base flow	1939–1969	0.094	0.535	--	--	1939–1950, 1955, 1960–2007	1939–1950, 1955, 1960–1968[4]	Fair	Good
				1971–2007	.161	.159	--	--				
				1939–2007	.106	<.0001	0.014	1.5				
			Base-flow index	1939–1969	.275	.063	--	--				
				1971–2007	.176	.122	--	--				
				1939–2007	.097	<.0001	.004	.8				
9	07154500	Cimarron River near Kenton, Okla.	Base flow	1951–1966	-.142	.457	--	--	1951–2007	1951–1966	Poor	No Change[5]
				1972–2007	-.038	.754	--	--				
				1951–2007	-.300	.001	.000	3.1				
			Runoff	1951–1966	.007	1.000	--	--				
				1972–2007	-.308	.009	-.003	-3.8				
				1951–2007	-.368	.000	-.004	-4.1				
			Total flow	1951–1966	.008	1.000	--	--				
				1972–2007	-.298	.011	-.003	-3.3				
				1951–2007	-.382	<.0001	-.004	-4.1				
			Base-flow index	1951–1966	-.125	.525	--	--				
				1972–2007	.110	.354	--	--				
				1951–2007	-.038	.680	--	--				
12	07157500	Crooked Creek near Englewood, Kans.	Base flow	1943–1975	.182	.141	--	--	1943–2007	1943–1963	Poor	No Change[6]
				1977–2007	-.286	.025	-.001	-.8				
				1943–2007	-.208	.041	-.001	-.5				
			Runoff	1943–1963	.038	.833	--	--				
				1965–2007	-.442	<.0001	-.003	-4.2				
				1943–2007	-.515	<.0001	-.004	-3.9				

Table 5. Results of Kendall's tau trend test of selected annual flow parameters for nine selected streamflow-gaging stations in and near Oklahoma.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; --, trend slope was not calculated because the trend was not statistically significant at a critical p-value of 0.05; <, less than; "no change" indicates that the baseline period of record or quality rank of the baseline period did not change as a result of the trend assessment]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Streamflow parameter	Period tested (water years)	Kendall's tau results: Kendall's tau	Kendall's tau results: Probability value	Trend slope (units per year)	Trend slope (percent of median for period tested, per year)	Preliminary baseline period of record: Prior to trend analysis	Preliminary baseline period of record: Adjusted from trend analysis	Preliminary quality rank: Prior to trend analysis	Preliminary quality rank: Adjusted from trend analysis
				1943–1963	0.038	0.833	--	--	1943–2007	1943–1963	Poor	No Change[6]
				1965–2007	-.442	<.0001	-0.003	-4.2				
				1943–2007	-.515	<.0001	-.004	-3.9				
				1943–1963	.029	.880	--	--				
12	07157500	Crooked Creek near Englewood, Kans.—Continued	Total flow	1965–2007	-.452	<.0001	-.005	-2.5				
				1943–2007	-.467	<.0001	-.005	-2				
				1943–1963	-.052	.763	--	--				
				1943–1975	.296	.016	.008	1.1				
			Base-flow index	1965–2007	.406	<.0001	.009	1.4				
				1977–2007	.297	.016	.008	2.2				
				1943–2007	.554	<.0001	.009	1.6				
35	07176500	Bird Creek at Avant, Okla.	Base flow	1946–1967	.124	.976	--	--	1946–1976	1946–1972	Poor	No Change
				1946–1972	.095	.509	--	--				
				1946–1976	.251	.054	--	--				
			Base-flow index	1946–1967	.129	.432	--	--				
				1946–1972	.185	.193	--	--				
				1946–1976	.218	.093	--	--				
83	07234100	Clear Creek near Elmwood, Okla.	Runoff	1966–1993	-.293	.034	-.006	-5.8	1966–1993	No Baseline Period	Poor	No Baseline Period
				1975–1993	-.046	.820	--	--				
			Total flow	1966–1993	-.237	.087	--	--				
				1975–1993	-.020	.940	--	--				
			Base-flow index	1966–1993	.328	.018	.014	2.2	1966–1993	No Baseline Period	Poor	No Baseline Period
				1975–1993	.059	.762	--	--				

Table 5. Results of Kendall's tau trend test of selected annual flow parameters for nine selected streamflow-gaging stations in and near Oklahoma.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; --, trend slope was not calculated because the trend was not statistically significant at a critical p-value of 0.05; <, less than; "no change" indicates that the baseline period of record or quality rank of the baseline period did not change as a result of the trend assessment]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Streamflow parameter	Period tested (water years)	Kendall's tau results				Preliminary baseline period of record		Preliminary quality rank	
					Kendall's tau	Probability value	Trend slope (units per year)	Trend slope (percent of median for period tested, per year)	Prior to trend analysis	Adjusted from trend analysis	Prior to trend analysis	Adjusted from trend analysis
85	07236000	Wolf Creek near Fargo, Okla.	Base flow	1943–1956	-0.275	0.119	--	--	1943–1971	1943–1956	Poor	No Change
				1960–1976	-.103	.592	--	--				
				1943–1976	-.095	.441	--	--				
			Runoff	1943–1956	-.011	1.000	--	--				
				1960–1976	-.063	.001	-0.014	-11.4				
				1943–1976	-.423	.001	-.009	-5.3				
			Total flow	1943–1956	-.099	.661	--	--				
				1960–1976	-.456	.012	-.015	-4.6				
				1943–1976	-.365	.003	-.012	-3.3				
			Base-flow index	1943–1956	-.033	.913		--				
				1960–1976	.603	.001	.019	3.1				
				1943–1976	.508	<.0001	.014	2.6				
104	07300500	Salt Fork Red River at Mangum, Okla.	Base-flow	1938–1957	.021	.923	--	--	1938–1966	No Change	Excellent	No Change
				1938–1966	.133	.320	--	--				
			Base-flow index	1938–1957	.005	1.000	--	--				
				1938–1966	.170	.202	--	--				
107	07301410	Sweetwater Creek near Kelton, Texas	Runoff	1963–1979	-.029	.902	--	--	1963–2007	1963–1978	Fair	No Change
				1981–2007	-.123	.381	--	--				
				1963–2007	-.220	.034	-.003	-1.4				
			Total flow	1963–1978	-.059	.773	--	--				
				1981–2007	-.083	.559	--	--				
				1963–2007	-.118	.257	--	--				
			Base-flow index	1963–1979	-.147	.434	--	--				
				1981–2007	.128	.359	--					
				1963–2007	.283	.006	.004	.6				

Table 5. Results of Kendall's tau trend test of selected annual flow parameters for nine selected streamflow-gaging stations in and near Oklahoma.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; --, trend slope was not calculated because the trend was not statistically significant at a critical p-value of 0.05; <, less than; "no change" indicates that the baseline period of record or quality rank of the baseline period did not change as a result of the trend assessment]

Map no. (fig. 1)	U.S. Geological Survey station ID	Station name	Streamflow parameter	Period tested (water years)	Kendall's tau results				Preliminary baseline period of record		Preliminary quality rank	
					Kendall's tau	Probability value	Trend slope (units per year)	Trend slope (percent of median for period tested, per year)	Prior to trend analysis	Adjusted from trend analysis	Prior to trend analysis	Adjusted from trend analysis
109	07301500	North Fork Red River near Carter, Okla.	Base flow	1938–1961	-0.048	0.778	--	--	1938–1962	1938–1961	Fair	No Change
				1965–2007	.391	.000	0.007	3				
			Runoff	1938–1961	.004	1.000	--	--				
				1965–2007	-.045	.676	--	--				
				1938–2007	-.224	.008	-.006	-1.4				
			Total flow	1938–1952	-.128	.583	--	--				
				1938–1961	-.039	.822	--	--				
				1953–2007	.054	.576	--	--				
				1965–2007	.132	.217	--	--				
				1938–2007	-.040	.642	--	--				
109	07301500	North Fork Red River near Carter, Okla.	Base-flow index	1938–1952	.205	.360	--	--	1938–1962	1938–1961	Fair	No Change
				1938–1961	-.082	.612	--	--				
				1953–2007	.626	<.0001	.010	2.9				
				1965–2007	.538	<.0001	.009	2.2				
				1938–2007	.568	<.0001	.007	2.3				

[1] Base-flow index is a unitless ratio (baseflow, in inches, divided by total flow, in inches), and base flow, runoff, and total flow are in inches per year.

[2] The period tested was based on results from analysis of covariance of double-mass curves, which relate cumulative annual flow to cumulative annual precipitation, that indicate years in which a statistically significant change in this relation have been detected. Results from this analysis are listed in table 4.

[3] The p-value is the probability that the null hypothesis for the statistical test, that there is no trend in the value over time, can be rejected. The critical p-value for rejection of the null hypothesis is set at 0.05. All p-values less than 0.05 are highlighted in red, and indicate that the trend is statistically significant.

[4] The percentage of the drainage-basin affected by impoundment was 5 percent in 1969 (table 2 of this report). Because of this impoundment, the least-altered period of record ended in 1968.

[5] Remarks in table 1 indicated that there were substantial diversions for irrigation. This diversion was documented prior to 1966, therefore, the period is still considered poor.

[6] Remarks in table 1 indicated that there were substantial diversions for irrigation. This diversion was documented prior to 1963, therefore, the period is still considered poor.

Table 6. Results of the determination of an optimum minimum number of years of streamflow record to consider as a baseline period of record on the basis of testing of variability of annual precipitation between shorter sub-periods and the period 1925–2007 using a Wilcoxon rank-sum test.

[Fraction of rejections, the percentage of sub-periods of the indicated record length where the null hypothesis of no difference in annual precipitation for the sub-period and the period 1925–2007 was rejected (at a probability of less than or equal to 0.05) for moving sub-periods starting with 1925; %, percent; AR, Arkansas; KS, Kansas; MO, Missouri; OK, Oklahoma; TX, Texas; None, no sub-periods were rejected for any moving period of the indicated record length; NA, not applicable]

Climate division number and region descriptor (fig. 3)	Normal period[1]							Wet period[1]						
	Fraction of rejections						Optimum minimum period of record[3]	Fraction of rejections						Optimum minimum period of record[3]
	5 year[2]	10 year	15 year	20 year	25 year	35 year		5 year	10 year	15 year	20 year	25 year	35 year[5]	
AR1 - Northwest	5%	None	4%	None	None	None	20	None	12%	9%	None	None	NA	20
AR4 - West Central	4%	2%	None	None	None	None	15	None	None	None	None	None	NA	10
AR7 - Southwest	2%	None	None	None	None	None	10	5%	24%	40%	10%	None	NA	25
KS7 - Southwest	14%	14%	None	None	None	None	15	None	None	None	None	None	NA	10
KS8 - South Central	4%	None	None	None	None	None	10	None	6%	None	None	None	NA	15
KS9 - Southeast	7%	4%	None	None	None	None	15	None	None	9%	None	None	NA	20
MO4 - West Ozarks	5%	2%	7%	7%	2%	None	35	None	6%	None	None	None	NA	15
OK1 - Panhandle	16%	14%	None	None	None	None	15	5%	None	None	None	None	NA	10
OK2 - North Central	5%	None	None	None	None	None	10	9%	None	9%	None	None	NA	20
OK3 - Northeast	10%	4%	None	4%	None	None	25	5%	18%	27%	None	None	NA	20
OK4 - West Central	9%	4%	None	None	None[4]	None	15	5%	None	18%	27%	None	NA	25
OK5 - Central	7%	2%	None	None	None	None	15	13%	23%	45%	36%	None	NA	25
OK6 - East Central	12%	None	3%	None	None	None	20	5%	47%	54%	45%	None	NA	25
OK7 - Southwest	5%	2%	2%	None	None	None	20	9%	29%	45%	36%	15%	NA	35
OK8 - South Central	4%	None	None	None	None	None	10	14%	29%	18%	9%	None	NA	25
OK9 - Southeast	2%	None	None	None	None	None	10	9%	29%	36%	9%	None	NA	25
TX1 - High Plains	5%	None	None	None	None	None	10	9%	None	None	None	None	NA	10
TX2 - Low Rolling Plains	3%	None	None	None	None	None	10	None	None	None	None	None	NA	10
TX3 - North Central	4%	2%	None	None	None	None	15	None	6%	None	None	None	NA	15
TX4 - East Texas	2%	None	None	None	None	None	10	9%	6%	None	None	None	NA	15

[1] The optimum minimum period of record was defined separately for sub-periods starting or mostly in the wet period, and sub-periods starting in the historically typical climate period, which was prior to 1980. For the 5- and 10-year sub-periods, rejections were tallied separately for sub-periods starting in 1925 through 1980, and sub-periods starting in 1981 through the current year. For the 15- , 20- , and 25-year periods, the cut-off year for defining the wet period started earlier in 1970.

[2] Sub-periods tested include all possible continuous periods of the indicated length. For example, for the test of sub-periods that are 5 years in length, annual precipitation for the periods 1925–1929, 1926–1930, 1927–1931, and so on, were each compared to annual precipitation for the period 1925–2007 by using a Wilcoxon rank-sum test to determine if the null hypothesis should be rejected.

[3] The optimum minimum number of years of record reflects the suggested minimum number of years of continuous streamflow data to use in a baseline period of record for those gages that are located in the respective climate division. The minimum number of years for a baseline period is defined here as the least number of years for which the null hypothesis was not rejected for any tested sub-period of that length.

[4] All rejections occurred for periods starting as late as 1933. All streanflow records started after 1933, so the rejections for this time frame reflect the non-wet period 1934–1978.

[5] A wet-period analysis was not performed separately for the 35-year periods.

Table 7. Final baseline period of record for 111 streamflow-gaging stations in and near Oklahoma with at least 10 years of continuous daily streamflow record and a drainage area of less than 2,500 square miles.

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; Final quality ranking of baseline period indicates the degree of alteration of the streamflow-gaging station and may be lowered if the record length is insufficient to account for climate variability; N, north; SCS, Soil Conservation Service]

Map no. (figs. 1 and 6)	U.S. Geological Survey station ID	Station name	Climate division	Drainage area (square miles)	Baseline period of record	Number of base-line years	Human activities that may affect baseline period	Final quality ranking of baseline period
1	07148350	Salt Fork Arkansas River near Winchester, Okla.	OK2	848.7	1960–1993	34	None Identified	Good
2	07148400	Salt Fork Arkansas River near Alva, Okla.	OK2	1,007.5	1939–1951	13	Irrigation	Good
3	07149000	Medicine Lodge River near Kiowa, Kans.	KS8	908	1939–1950, 1960–1968	21	None Identified	Good
4	07149500	Salt Fork Arkansas River near Cherokee, Okla.	OK2	2,420	1941–1950	10	None Identified	Good
5	07151500	Chikaskia River near Corbin, Kans.	KS8	833.6	1951–1965, 1976–2007	47	None Identified	Fair
6	07152000	Chikaskia River near Blackwell, Okla.	OK2	1,921.6	1937–1949	13	None Identified	Fair
7	07153000	Black Bear Creek at Pawnee, Okla.	OK3	552.3	1945–1960	16	Minor Regulation	Poor
9	07154500	Cimarron River near Kenton, Okla.	OK1	1,140.4	1951–1966	16	Irrigation	Poor
10	07155000	Cimarron River above Ute Creek near Boise City, Okla.	OK1	2,017.6	1943–1954	12	Irrigation, Diversion	Poor
12	07157500	Crooked Creek near Englewood, Kans.	KS7	843.3	1943–1963	21	Irrigation	Poor
13	07157900	Cavalry Creek at Coldwater, Kans.	KS7	39	1967–1980	14	None Identified	Good
14	07157960	Buffalo Creek near Lovedale, Okla.	OK1	411.7	1967–1993	27	Minor Regulation	Poor
16	07159000	Turkey Creek near Drummond, Okla.	OK2	261.4	1948–1970	23	Diversion	Poor
19	07160500	Skeleton Creek near Lovell, Okla.	OK5	422.7	1950–1993, 2002–2007	58	None Identified	Good
20	07163000	Council Creek near Stillwater, Okla.	OK5	30.8	1935–1960	26	None Identified	Good
25	07170700	Big Hill Creek near Cherryvale, Kans.	KS9	37.8	1958–1980	23	None Identified	Good
26	07172000	Caney River near Elgin, Kans.	KS9	445	1940–1964	25	Minor regulation	Good
27	07173000	Caney River near Hulah, Okla.	OK3	729.2	1938–1949	12	None Identified	Fair
28	07174200	Little Caney River below Cotton Creek, near Copan, Okla.	OK3	516.4	1939–1963	24	None Identified	Good
30	07174600	Sand Creek at Okesa, Okla.	OK3	141.4	1960–1993	34	Minor Regulation	Poor
35	07176500	Bird Creek at Avant, Okla.	OK3	378.1	1946–1972	27	Minor Regulation	Poor
36	07176800	Candy Creek near Wolco, Okla.	OK3	32.2	1970–1980	11	None Identified	Good
37	07177000	Hominy Creek near Skiatook, Okla.	OK3	340	1944–1980	37	None Identified	Good
38	07177500	Bird Creek near Sperry, Okla.	OK3	930.5	1939–1957	20	Diversion	Fair
44	07184000	Lightning Creek near McCune, Kans.	KS9	201	1939–1946, 1960–2007	56	None Identified	Excellent
46	07185500	Stahl Creek near Miller, Mo.	MO4	4.1	1951–1976	26	None Identified	Poor

Table 7. Final baseline period of record for 111 streamflow-gaging stations in and near Oklahoma with at least 10 years of continuous daily streamflow record and a drainage area of less than 2,500 square miles.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; Final quality ranking of baseline period indicates the degree of alteration of the streamflow-gaging station and may be lowered if the record length is insufficient to account for climate variability; N, north; SCS, Soil Conservation Service]

Map no. (figs. 1 and 6)	U.S. Geological Survey station ID	Station name	Climate division	Drainage area (square miles)	Baseline period of record	Number of baseline years	Human activities that may affect baseline period	Final quality ranking of baseline period
47	07185700	Spring River at LaRussell, Mo.	MO4	313.5	1958–1973, 1976–1980	21	None Identified	Poor
48	07185765	Spring River at Carthage, Mo.	MO4	459.4	1967–1980, 2002–2007	20	None Identified	Good
49	07186000	Spring River near Waco, Mo.	MO4	1,164	1924–2007	84	None Identified	Fair
50	07187000	Shoal Creek above Joplin, Mo.	MO4	438.5	1942–2007	66	None Identified	Excellent
52	07188500	Lost Creek at Seneca, Mo.	MO4	41.8	1949–1959	11	None Identified	Good
53	07189000	Elk River near Tiff City, Mo.	MO4	872.7	1940–2007	68	Backwater from Regulation	Fair
54	07189540	Cave Springs Branch near South West City, Mo.	MO4	8.2	1997–2007	11	None Identified	Good
55	07189542	Honey Creek near South West City, Mo.	OK3	49.9	1997–2007	11	None Identified	Good
56	07191000	Big Cabin Creek near Big Cabin, Okla.	OK3	462	1948–2007	60	Effluent, Irrigation	Poor
57	07191220	Spavinaw Creek near Sycamore, Okla.	OK3	135	1962–2007	46	None Identified	Good
58	07192000	Pryor Creek near Pryor, Okla.	OK3	233.3	1948–1963	16	None Identified	Good
60	07195000	Osage Creek near Elm Springs, Ark.	AR1	133.3	1966–1975, 1996–2007	22	Effluent, Minor Regulation	Fair
61	07195430	Illinois River South of Siloam Springs, Ark.	AR1	582.5	1996–2006	11	Minor Regulation	Poor
62	07195500	Illinois River near Watts, Okla.	OK6	646.1	1991–2007	18	Diversion	Poor
63	07195800	Flint Creek at Springtown, Ark.	AR1	15.1	1962–1963, 1965–1979, 1981–2007	44	None identified	Good
65	07195865	Sager Creek near West Siloam Springs, Okla.	OK3	19.6	1997–2007	11	Effluent	Poor
66	07196000	Flint Creek near Kansas, Okla.	OK3	118.6	1956–1977	22	Irrigation	Poor
67	07196500	Illinois River near Tahlequah, Okla.	OK6	974.9	1936–1977	42	Minor Regulation	Fair
68	07196900	Baron Fork at Dutch Mills, Ark.	AR1	42.2	1959–2007	49	None Identified	Excellent
69	07196973	Peacheater Creek at Christie, Okla.	OK6	25.5	1993–2003	11	None Identified	Good
70	07197000	Baron Fork at Eldon, Okla.	OK6	319.7	1949–2007	59	None identified	Good
71	07197360	Caney Creek near Barber, Okla.	OK6	92.5	1998–2007	10	None Identified	Fair
72	07198000	Illinois River near Gore, Okla.	OK6	1,656.8	1940–1951	12	None Identified	Good
73	07229300	Walnut Creek at Purcell, Okla.	OK5	207.4	1966–1993	28	Backwater from Regulated Stream	Fair
74	07230000	Little River below Lake Thunderbird near Norman, Okla.	OK5	257	1953–1962	10	None Identified	Poor
75	07230500	Little River near Tecumseh, Okla.	OK5	474.5	1944–1964	21	Irrigation	Fair

Table 7. Final baseline period of record for 111 streamflow-gaging stations in and near Oklahoma with at least 10 years of continuous daily streamflow record and a drainage area of less than 2,500 square miles.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; Final quality ranking of baseline period indicates the degree of alteration of the streamflow-gaging station and may be lowered if the record length is insufficient to account for climate variability; N, north; SCS, Soil Conservation Service]

Map no. (figs. 1 and 6)	U.S. Geological Survey station ID	Station name	Climate division	Drainage area (square miles)	Baseline period of record	Number of baseline years	Human activities that may affect baseline period	Final quality ranking of baseline period
76	07231000	Little River near Sasakwa, Okla.	OK5	911.4	1943–1961	19	None Identified	Good
77	07232000	Gaines Creek near Krebs, Okla.	OK6	600.3	1943–1963	21	None Identified	Excellent
78	07232500	Beaver River near Guymon, Okla.	OK1	1,653.5	1938–1960	23	Minor Regulation	Fair
80	07233000	Coldwater Creek near Hardesty, Okla.	OK1	1,055.5	1940–1964	25	None Identified	Excellent
81	07233500	Palo Duro Creek near Spearman, Texas	TX1	640.9	1946–1969	24	Diversion	Good
85	07236000	Wolf Creek near Fargo, Okla.	OK1	1,511.1	1943–1956	16	Impoundment	Poor
89	07243000	Dry Creek near Kendrick, Okla.	OK5	70.1	1956–1994	39	None Identified	Good
90	07243500	Deep Fork near Beggs, Okla.	OK6	2,056.2	1939–1960	22	Minor Regulation	Good
91	07244000	Deep Fork near Dewar, Okla.	OK6	2,355.5	1938–1950	13	Minor Regulation	Fair
92	07245500	Sallisaw Creek near Sallisaw, Okla.	OK6	185.8	1943–1962	20	Diversion	Poor
93	07247000	Poteau River at Cauthron, Ark.	AR4	208.8	1940–1963	29	Minor Regulation	Good
95	07247250	Black Fork below Big Creek near Page, Okla.	OK9	96.8	1992–2007	16	None Identified	Good
96	07247500	Fourche Maline near Red Oak, Okla.	OK9	123.5	1939–1963	25	Impoundment	Fair
97	07248500	Poteau River near Wister, Okla.	OK9	1,019.4	1939–1948	10	None identified	Good
98	07249400	James Fork near Hackett, Ark.	AR4	150.5	1959–2007	19	Diversion/ Withdrawal	Fair
100	07249500	Cove Creek near Lee Creek, Ark.	AR4	35.7	1950–1970	21	None Identified	Good
101	07249985	Lee Creek near Short, Okla.	OK6	445.3	1931–1936, 1950–1991, 1993–2007	63	None Identified	Excellent
102	07250000	Lee Creek near Van Buren, Ark.	OK6	449.3	1931–1936, 1951–1992	48	None Identified	Excellent
103	07300000	Salt Fork Red River near Wellington, Texas	TX2	1,029.4	1953–1966	14	Irrigation	Fair
104	07300500	Salt Fork Red River at Mangum, Okla.	OK7	1,380.4	1938–1966	29	None identified	Excellent
107	07301410	Sweetwater Creek near Kelton, Texas	TX2	305	1963–1978	15	Diversion	Fair
109	07301500	North Fork Red River near Carter, Okla.	OK4	2,155	1938–1961	25	None Identified	Fair
111	07303400	Elm Fork of N Fork Red River near Carl, Okla.	OK7	449.3	1960–1979, 1995–2007	33	Diversion/ Withdrawal	Poor
112	07303500	Elm Fork of N Fork Red River near Mangum, Okla.	OK7	868.3	1938–1976	39	Minor Regulation	Fair
113	07304500	Elk Creek near Hobart, Okla.	OK7	563.5	1950–1966	17	Irrigation	Poor
118	07311500	Deep Red Creek near Randlett, Okla.	OK7	619.7	1950–1963, 1970–1973	18	None identified	Good
119	07313000	Little Beaver Creek near Duncan, Okla.	OK8	160.6	1949–1963	15	None Identified	Good

Table 7. Final baseline period of record for 111 streamflow-gaging stations in and near Oklahoma with at least 10 years of continuous daily streamflow record and a drainage area of less than 2,500 square miles.—Continued

[no., number; ID, identifier; a water year is the 12-month period beginning October 1 and ending September 30 and is named for the year in which it ends; Final quality ranking of baseline period indicates the degree of alteration of the streamflow-gaging station and may be lowered if the record length is insufficient to account for climate variability; N, north; SCS, Soil Conservation Service]

Map no. (figs. 1 and 6)	U.S. Geological Survey station ID	Station name	Climate division	Drainage area (square miles)	Baseline period of record	Number of baseline years	Human activities that may affect baseline period	Final quality ranking of baseline period
120	07313500	Beaver Creek near Waurika, Okla.	OK8	579	1954–1976	23	None Identified	Good
121	07315700	Mud Creek near Courtney, Okla.	OK8	589.3	1961–2007	47	Minor Regulation	Good
122	07316500	Washita River near Cheyenne, Okla.	OK4	782.3	1938–1957	18	Irrigation	Poor
128	07325000	Washita River near Clinton, Okla.	OK4	1,998.8	1936–1955	20	Irrigation, Minor Regulation	Fair
130	07326000	Cobb Creek near Fort Cobb, Okla.	OK7	318.8	1940–1950	11	Minor Regulation	Good
133	073274406	Little Washita River above SCS Pond 26 near Cyril, Okla.	OK7	3.7	1995–2007	13	None Identified	Good
136	07327490	Little Washita River near Ninnekah, Okla.	OK5	213.3	1952–1969	18	Irrigation, Minor Regulation	Poor
140	07329000	Rush Creek at Purdy, Okla.	OK8	143.3	1940–1953	26	None Identified	Good
145	07330500	Caddo Creek near Ardmore, Okla.	OK8	304	1937–1950	14	None Identified	Excellent
146	07332400	Blue River at Milburn, Okla.	OK8	208.5	1966–1986	21	None Identified	Excellent
147	07332500	Blue River near Blue, Okla.	OK8	489.8	1937–1980	44	Minor Regulation	Fair
148	07332600	Bois D'Arc Creek near Randolph, Texas	TX3	74	1964–1985	22	None Identified	Excellent
149	07333500	Chickasaw Creek near Stringtown, Okla.	OK8	33.5	1956–1968	13	None Identified	Excellent
150	07333800	McGee Creek near Stringtown, Okla.	OK8	91.1	1956–1968	13	None Identified	Excellent
151	07334000	Muddy Boggy Creek near Farris, Okla.	OK8	1,117.1	1938–1958	21	None Identified	Excellent
152	07335000	Clear Boggy Creek near Caney, Okla.	OK8	731.8	1943–1960	18	None Identified	Good
155	07335700	Kiamichi River near Big Cedar, Okla.	OK9	40.7	1966–2007	42	None identified	Excellent
157	07336000	Tenmile Creek near Miller, Okla.	OK9	70.1	1956–1970	15	None Identified	Excellent
158	07336200	Kiamichi River near Antlers, Okla.	OK9	1,158.3	1973–1982	10	Diversion	Fair
159	07336500	Kiamichi River near Belzoni, Okla.	OK9	1,452.6	1926–1972	47	Diversion	Fair
160	07336750	Little Pine Creek near Kanawha, Texas	TX4	77.2	1970–1980	11	None Identified	Good
161	07336800	Pecan Bayou near Clarksville, Texas	TX4	101.5	1963–1977	15	None Identified	Good
162	07337500	Little River near Wright City, Okla.	OK9	665	1945–1966	22	None identified	Excellent
163	07337900	Glover River near Glover, Okla.	OK9	328.6	1962–2007	46	None Identified	Excellent
164	07338500	Little River below Lukfata Creek, near Idabel, Okla.	OK9	1,260	1930–1968	39	Diversion/ Withdrawal	Fair
165	07338750	Mountain Fork at Smithville, Okla.	OK9	330.7	1992–2007	16	None Identified	Poor
166	07339000	Mountain Fork near Eagletown, Okla.	OK9	820.5	1930–1968	39	None Identified	Good
167	07339500	Rolling Fork near DeQueen, Ark.	AR7	188.1	1949–1976	28	None Identified	Excellent
168	07340300	Cossatot River near Vandervoort, Ark.	AR4	91.4	1967–2007	29	None identified	Excellent

Table 7. Final baseline period of record for 111 streamflow-gaging stations in and near Oklahoma with at least 10 years of continuous daily streamflow record and a drainage area of less than 2,500 square miles.—Continued

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Map no. (figs. 1 and 6)	U.S. Geological Survey station ID	Station name	Climate division	Drainage area (square miles)	Baseline period of record	Number of baseline years	Human activities that may affect baseline period	Final quality ranking of baseline period
169	07340500	Cossatot River near DeQueen, Ark.	AR7	370.6	1939–1974	36	None Identified	Good
170	07341000	Saline River near Dierks, Ark.	AR7	123.3	1939–1974	36	None Identified	Excellent
171	07341200	Saline River near Lockesburg, Ark.	AR7	259.3	1964–1974	11	None Identified	Excellent

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