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COMPILATION AND ANALYSIS OF HISTORIC DATA RELATED TO FLOWS ON THE OBED RIVER AND TRIBUTARY STREAMS

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A cooperative project between the National Park Service and the U.S. Geological Survey

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COMPILATION AND ANALYSIS OF HISTORIC DATA RELATED TO FLOWS ON THE OBED RIVER AND TRIBUTARY STREAMS

Version June, 2002

INTRODUCTION

Obed Wild and Scenic River (OBRI) was included in the National Wild and Scenic Rivers system on October 12, 1976 because it possesses "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values" (Wild and Scenic Rivers Act, 82 Stat. 906, P.L. 90-542). The Wild and Scenic Rivers Act established a policy for the United States to preserve selected rivers in their free-flowing condition and to protect their water quality and other vital national conservation purposes. The water resources of the Obed River are considered to be among the highest quality in the State, but occur in an area with comparatively limited water resources and increasing development and water consumption. The level of regional development now occurring makes water quantity and quality within the Obed River Basin a concern. Baseline hydrologic data has been collected by several agencies for multiple reasons and applications. However, a coherent compilation and assessment of this data has not been made.

The purpose of this report is to present a compilation and analytical summary of historic data affecting the hydrology of the Obed River Basin with an emphasis on pre- and post-OBRI establishment. The Obed River is tributary to the Emory River. Therefore, all stations within the Emory River Basin were included. The compilation shows what data is available. The basic data analysis is intended to increase understanding of basin hydrology. The report should also provide a base from which further investigations can be formulated.

Available hydrologic data for the Emory River and Obed River Basins has been identified and summarized. This report provides statistical analyses of historic data recorded at stream gages that are pertinent to the study area. The analyses emphasize some key components of stream hydrology that are critical to maintaining the character of the Obed Wild and Scenic River.

DATA COMPILATION

Several agencies have generated and hold data pertinent to area hydrology. The U.S. Geological Survey (USGS) has stream flow and rainfall data. The National Park Service (NPS) report "Baseline Water Quality Data Inventory and Analysis, Obed Wild and Scenic River" (NPS, 1999) contains information about streamflow data sources. The Tennessee Valley Authority (TVA) has rainfall data. Public water suppliers, Tennessee Department of Environment and Conservation (TDEC), and the USGS have data on water withdrawal. Area wastewater treatment plants and TDEC have data on effluent releases. Population dynamics data have been compiled by the U.S. Census Bureau.

Surface-Water Data

Surface-water data has been collected in the study area since at least 1921. The longest record is at 03540500 Emory River at Oakdale, Tennessee; 1929 to present. This is also the most downstream station. Other gages have been operated and sampling has been done for specific projects over much shorter time frames. The NPS has made an effort to gather data sources. The USGS has the vast majority of the documented data in archive.

National Park Service

The NPS report "Baseline Water Quality Data Inventory and Analysis, Obed Wild and Scenic River" (NPS,1999) contains an extensive list of sites in the Obed River Basin at which water quality sampling was done. The presence of discharge data at each site is one part of each station listing. This is listed as Continuous Discharge or Instantaneous Discharge. Continuous Discharge is the organized, sustained recording of flows. Instantaneous Discharge is the measurement of discharge at the time of sampling. Dates of data collection for each site were listed.

Table 1 lists the stations gleaned from "Baseline Water Quality Data...". The list indicates that there has been a lot of attention and work devoted to the Obed River Basin. It also demonstrates that much of this work has been for narrowly focused investigations and that the data are fragmented over time and space.

USGS

The USGS has operated gaging stations in the Obed River and Emory River basins for both TVA and for internal studies (table 2). USGS currently operates three stations in the Obed River Basin cooperatively with Tennessee Wildlife Resources Agency (TWRA) and NPS. TVA has been and is generally interested in flow status as part of their river operations model. Historic data was collected to determine how far down in the basin a station could be located and still provide data within acceptable model error limits. Eventually TVA determined that the most downstream station in the Emory River Basin, 03540500 Emory River at Oakdale, provided all the information they needed. This precluded the need for other upstream sites, and support by TVA was discontinued.

USGS established many Low Flow Partial Record stations (LFPR) and Miscellaneous sites in the basin (table 2). Again, those stations were for specific uses such as low flow statistic generation or water quality programs. At one time the State supported LFPR data collection. As statistics were generated and State agency funding decreased, LFPR data ceased to be collected. Water quality programs such as the Coal Hydrology Program (1979-81) and National Water Quality Assessment Program provided new data, but again it was for specific uses and not part of a coherent water quantity program.

Only 12 of the stations listed in table 2 have continuous data. Five of those had 5 or fewer years of record. Several had data so old that it is available in hardcopy only, and then only in summary format. When viewed in terms of pre- and post-1976 records (table 3), 03540500 Emory River at Oakdale has the best record. It also has the largest drainage area (764 sq. mi.). This decreases the likelihood that changes in hydrology can be revealed. 03539800 Obed River near Lancing has the next best data set, but again, a large drainage area (518 sq. mi.). There are other pre-1976 data sets, Emory River near Wartburg and the Daddys Creek stations, but there is little post-1976 data.

Flood frequency estimates for the Emory River Basin (table 4) represent a mixed bag of sources and time blocks. The number of stations with flood-frequency return-period estimates can falsely relay the impression that many continuous record stations have been operated in the Basin. A search of table 2 for stations listed in table 4 shows that some flood frequency estimates are based on both continuous records and annual peaks from crest stage gages (CSG). Some flood frequency estimates are based solely on CSG data. Estimates for most stations cross the 1976 time boundary.

Low-flow statistics for the basin have been computed through 1992 (Outlaw and Weaver, 1996). The value for the 7Q10 (table 5), the estimated lowest flow over 7 days that might occur in 10 years, is presented because the State uses that statistic for low-flow assessment. Only 03539800 Obed River near Lancing and 03540500 Emory River at Oakdale have data sets that cross the 1976 time mark (table 5). It should be noted that none of the Low Flow Partial Record (LFPR) stations listed in Outlaw and Weaver (1996) had sufficient data to make an estimate of the 7Q10.

Rainfall Data

Rainfall records for the study area are scarce (table 6). USGS had three sites in the headwaters of Daddys Creek covering the years 1966-1975. On close examination they were found to have questionable data and were not used for analyses. TVA has a good geographic spread of gages covering 1986-present that will be useful for comparison with surface water data currently being collected.

Records obtained from NOAA-NCDC are from stations in Sunbright, Lancing, and the Crossville area (table 6). The Sunbright gage has a short period of record and was not used in this effort. The Lancing gage will be useful for comparisons with future data. NCDC's Crossville Airport gage covers 1954-present and the Crossville Experiment Station gage covers 1912-present.

Due to period of record, only Crossville Experiment Station and Crossville Airport rainfall data are usable for comparison with historic stream-flow data. The two stations are in close proximity, with Crossville Airport being slightly more central in the basin. Usable Crossville Experiment Station data starts in 1914 and continues to the present. Crossville Airport data starts in 1954 and continues to the present. Figure 1 shows that Crossville Airport and Crossville Experiment station raingage annual totals are comparable. The plot shows that annual rainfall totals can range from near 35 inches to

over 80 inches. The actual overlay of data from the two stations (figure 2) shows close similarity.

Population Statistics

Population summary totals for areas pertinent to the study area are listed in table 7. The obvious conclusion is that Cumberland County is growing rapidly while Morgan County is growing, but more slowly. From 1990 to 2000 Fairfield Glade had a 121 % population increase. Crossville had a 29.6 % increase. Heady growth for population centers dependent on limited water resources.

Total population as opposed to specific population centers may have different affects on area hydrology. Total population is an indication of overall need for drinking water and potential effluent release. Dispersed housing releases effluent to septic systems. Concentrated housing (Fairfield Glade, Crossville, etc.) releases effluent to point sources generally. Water supplied by public suppliers generally comes from surface water sources and reaches a limited number of people, usually in the more densely populated areas. The Obed River headwaters are the major source for Cumberland County population centers. Rather that coming from intakes in the rivers, the supplies come from lakes that trap and store water that otherwise would flow down tributary streams and the river.

Impoundments in the Basin

Impoundment of headwater areas has the potential to affect area hydrology. Developers add ponds to their plans for aesthetics. Increased drinking water reservoir capacity on headwater streams has been the frequent first choice of planners. Both TVA and COE have done studies regarding drinking water options for the Cumberland Plateau area, and both have recommended accessing water from off the Plateau. This has yet to put to rest the perceived need for large drinking water reservoirs on area headwaters and has no affect on aesthetic developments.

Impoundments change the downstream hydrology. Even run of the river type lakes create an altered environment. Ponds and lakes affect the timing of flows and therefore the shape of the hydrograph, resulting in lower peaks and attenuated low flows. Ponds can cause more infiltration and sustain low flows later than normal into the dry season. Skimming of peaks by impoundments can affect the riparian zone by denying over bank flow and reducing sediment deposition on which some floodplain species depend. Some floodplain species are dependent on over bank flows for seed or vegetative dispersement. Reduced peaks may affect sediment transport in channels, affecting bed sediment composition and habitat. In-channel features could be affected. Each geomorphic feature in the channel is dependent on a specific flow level. Altering flow characteristics affects some features.

While the focal point of this report is water quantity, it is recognized that water quality is directly connected to quantity. Changes in flow regime cause changes in quality. Ponds

and lakes can act as nutrient sinks or sources and affect physical and chemical characteristics of the water moving through them. Changes in quantity and quality regimes result in an altered, artificial ecology.

Obed River Basin impoundment data for 1943 to 1994 was generated by TVA. The data is in GIS format and resides with USGS and NPS-BISO. The pre- and post-1976 summary in table 8 shows that the post-1976 period has had a tremendous increase in numbers of ponds or impoundments and in the total impoundment surface area. The Daddys Creek Basin has had the largest increase, going from a pre-1976 impoundment surface area of 122 acres to a post-1976 total value of 1,769 acres. The Obed River, excluding Daddys Creek and Clear Creek, has had a similar change in impoundments and acreage. Clear Creek basin has had the least total impoundment increase, and has the least acres per pond. Values in table 8 cover only impoundment surface area. The headwater area controlled by the dams has not been tabulated.

Water Withdrawal and Effluent Release

Drinking-water withdrawal is generally limited to surface water in the headwaters of Obed River Basin streams. There are a very few wells supplying public sources. Many households beyond the reach of public utilities depend on wells. USGS and Tennessee Department of Environment and Conservation, Division of Water Supply have been tabulating water supply information over the last 15 years. Table 9 lists suppliers, withdrawal amounts and sources. It should be noted that Crossville Water Department was a supplier of water to Crab Orchard until Crab Orchard brought Otter Creek Impoundment on line. Also note that Crossville takes water from a Caney Fork tributary, Meadow Park Lake. In 1988, withdrawal from Obed River sources was about 2.55 million gallons per day (mgd) (Hutson and Morris, 1992). In 1995, withdrawal from Obed River sources was 2.795 mgd (Hutson, 1999). Crossville took an additional 3.13 mgd from Meadow Park Lake (Hutson, 1999). In 2000, withdrawal from the Obed River was 3.25 mgd (TDEC Electronic Data Base). Water needs and use have increased along with population.

Crossville and Crab Orchard take their water from lakes. These lakes are fed from Obed River Basin streams. Therefore they are affecting flow. Release of effluent back into the environment constitutes a separate effect.

The City of Crossville and Fairfield Glade Resort are the major sources of effluent release in the Obed River Basin. Available data in monthly format is summarized in table 10 and figure 3. A brief review of the data shows that Crossville effluent release increases for the higher rainfall months. This is due to sewer line infiltration and storm drains. There is a cycle to Fairfield Glade releases also, but it appears to be associated with the high visitation times of the year.

Monthly average effluent release makes up a large percentage of the flow past 03539800 Obed River near Lancing, drainage area 518 square miles, during the low-flow part of the

year (table 10 and figure 4). For March 1999 through April 2002, effluent has at times made up as much as 57 percent of 03539800 flow. Effluent release from Fairfield Glade into Daddys Creek shows a similar cycle to that of Crossville and Obed River, but the overall percentages are lower. As long as populations increase in the basin headwaters, effluent flow will remain a major factor in seasonal low flows.

SURFACE-WATER DATA ANALYSES

Surface-water data can be broken down by year, month, and day in order to compare time blocks and sub-basins. Given the nature of this effort, data was reviewed and summarized by year and month only. This data was also reviewed by hydrologic characteristic such as flow percentiles and flow duration of specified days. Because the available historical data set is largely comprised of daily mean values, individual storm characteristics are not analyzed.

Flow Duration

Flow duration is the percentage of the period of record that flow is equaled or exceeded for a site. If the period of record is such that it can be considered representative of the long-term conditions, the duration values can be used in developing probability of future flows. For the Emory and Obed Rivers seven sites were used to present period-of-record flow duration (table 11). Emory River at Deermont (03540000) was excluded from this analysis because the period of record, 1920 to 1928, has no comparable overlap with other basin stations.

The values presented in table 11 are based on different time periods for most gages. There are periods within several gage records that overlap other gages. These summary values are therefore based on potentially different hydrologic and climatic conditions. They do however provide insight into the hydrology of the various basins.

Station 03538600, Obed River at Crossville, is above the Crossville sewage treatment plant and flow is mostly from upstream lakes. This results in the low-flow end of the flow duration being somewhat artificially sustained.

Stations 03538500, Emory River near Wartburg, and 03539500, Daddys Creek near Crab Orchard, have similar drainage areas and similar periods of record. Yet 03538500 has a much less well-sustained low flow than 03539500 (table 11, cfs). The CSM values help illustrate the effect of geology and ground water contribution on flow duration. Station 03538500 flow comes from consistent Pennsylvanian geology while station 03539500 has some limestone geology present in the headwaters. That effect is further demonstrated at 03539600, Daddys Creek near Hebbertsburg.

Duration values for 03539778, Clear Creek at Lilly Bridge, are based on too few years of data to be used for statistical testing. They are presented simply as a summary of available data.

Only stations 03539800 Obed River near Lancing and 03540500 Emory River at Oakdale have long term data that covers both pre-1976 and post-1976 time periods. When the pre- and post-76 values (table 12) for 03539800 are compared with the period of record values, it appears that the values are comparable. When the same comparison is made for 03540500 it is clear that there are fairly gross differences particularly for the low flows. When the pre-76 period for 03540500 is constrained to 1958 to 1976 the low flow values

are still substantially different than those for the entire period of record or for the post-76 values, but closer to the post-76 values. This illustrates some inconsistency within the long-term conditions. Period of record makes a difference when evaluating flow data for trends.

Flow duration analysis can be taken further by examining the percentiles for trends over time. Flow-duration percentiles at various levels are indicative of watershed characteristics during particular parts of the annual hydrograph. Annual low-flows are described with the zero percentile. Annual peaks are described with the 100th percentile. Other percentiles serve to document intermediate sections of the duration curve shape.

Low Streamflow Percentiles

Trend analyses were done for daily-mean values for the annual 0th, 10th, and 30th percentiles (table 13). Highlighted p-values (table 13) show those time periods with significant trends. Emory River at Oakdale (03540500) is the only station with significant trends. Figures 5, 6, and 7 show the data distributions. There appears to be a change in the distribution in the mid-1960's. When the data is tested on either side of 1965, there is no significant trend (table 13). Data beyond 1975 does not show a trend either. This makes it appear as though the few years of shifted pattern from 1965 to 1975 are enough to create the trend in the period 1929 to 1975.

Low Streamflow Duration

Low, annual, streamflow means for 7, 14, and 30 consecutive days for 03540500 Emory River at Oakdale, Tennessee were analyzed for trend (table 14, figures 8, 9, 10). All three categories had significant positive trends for the period of record, 1929 through 2000. When LOESS is applied, it appears that there is a change in cycle at about 1960 (figures 8, 9, 10).

High Streamflow Percentiles

Trend analyses were done for daily-mean values for the annual 70th, 90th, and 100th percentiles (table 15). The Obed River near Lancing (03539800) was tested as period of record, and then broken into approximately pre- and post-1976 blocks. Emory River at Oakdale (03540500) was tested as period of record and then broken into pertinent time frames based on other basin stations.

For the Emory River at Oakdale the 70th percentile has a positive trend for the period of record (table 15). The 1929 to 1975 period also has a positive trend (table 15, figure 11). The 1974 to 1987 period for Emory River at Oakdale has a negative trend (table 15, figure 11). As with all testing, specific short periods may represent a part of a cycle, and should be viewed cautiously when extrapolating to longer time periods. Those periods under the 100th percentile section of table 15 (figure 12) that tested as significant should also be viewed with caution for the same reason. It should be noted that LOESS is

generally a tool for overview or exploratory data analysis. Conversely, LOESS also helps visualize the patterns or trends detected by the Kendall Tau test.

Rainfall Trend Analysis

Long term rainfall records for the Obed River Basin and Emory River Basin are available only at Crossville Experiment Station and Crossville Airport. There are shorter term records available that are not suitable for this analysis, but will be suitable for future comparative work. Rainfall record from Crossville Experiment Station and Crossville Airport were tested for trends. To compliment the discharge trend analysis, rainfall was tested on a water-year basis. Crossville Experiment station has water-year record available from 1915 through 1999. Crossville Airport has water-year record available for 1955 through 1999.

Table 16 shows those periods tested and the periods with significant trends. For Crossville Experiment Station the period from 1915 through 1999 and from 1929 through 1999 have a positive trend. For both stations the period from 1955 to 1999 had no trend. Figures 13 and 14 show the data distributions. When the tested time periods are examined with LOESS, further patterns emerge. For Crossville Experiment Station from 1915 through 1999 LOESS demonstrates a general downward trend from 1915 to about 1937, then a general upward trend through 1999 (figure 15). When 1929 through 1999 are viewed in this manner there is a general upward trend for the entire period (figure 16).

Rainfall-Runoff Comparisons

Rainfall-runoff yield comparisons were made on an annual and monthly basis. Yield is that portion of rainfall that is measured as having passed a gaging station. This includes stormflow and baseflow. For these analyses, type of flow was not differentiated.

Annual data

Table 17 shows the period-of-record mean yields for discharge stations in the Emory River Basin. The mean yield for basin stations ranges from 0.42 to 0.49. Figure 17 shows the annual yield distributions for 03540500 Emory River at Oakdale and 03539800 Obed River near Lancing. The comparison raingage is located in the headwaters of the basin near Crossville, which may create bias. The plot is intended to demonstrate the cycles of yield. Water year 1981 has the lowest annual yield. Any yearly value approaching the 0.30 line would be considered a low mean-flow year.

Comparison of cumulative totals for two related variables may show if and when they diverge. Cumulative rainfall and runoff, in inches, were compared for 03539800 and 03540500 in this way (figures 18 and 19). There is some slight scatter about the regression line, but the coefficients of variation (.99) indicate that variation is minimal. The rainfall to runoff ratio is consistent on an annual basis. This does not address potential changes during the year.

Monthly data

Further examination was done using monthly data. Table 18 lists the by-month summary statistics for the two rainfall sites, Crossville Experiment Station and Crossville Airport, for the concomitant period of record. The presentation is in water year sequence. This makes it possible to see the annual progression from a fully drained, dry system to wet and then draining condition. October is the driest month with March being the most consistently wet month.

Monthly analysis of runoff was performed on the longest term flow record in the basin, 03540500 Emory River at Oakdale. Kendall trend testing of runoff in inches for each month identified June and October as having statistically significant trends (table 19).

Trend analysis by month was done for the Crossville Experiment Station rainfall record for the same period used on Emory River runoff. Months with significant trends are highlighted in table 19. A rainfall trend could result in a runoff trend, as inferred for the Crossville Experiment Station May rainfall and Emory River June runoff analysis (table 19).

October is normally the lowest runoff and lowest rainfall month of the year. Trend testing did not reveal a significant trend for September or October rainfall. The presence of a positive trend in October runoff (table 19) may indicate an unidentified influence on flow generation.

Other than 03540500 Emory River at Oakdale and 03539800 Obed River near Lancing, discharge sites in the basin had only pre-76 data (table 3). Comparison of runoff values between sites with concomitant data periods provides some insight, regardless of time period. Figure 20 shows that over their common period of record, stations 03539800, Obed River near Lancing, and 03539600, Daddys Creek near Hebbertsburg, had very similar monthly runoff characteristics. Comparison of runoff from 03538500, Emory River near Wartburg, and 03539500, Daddys Creek near Crab Orchard, (figure 21) also show very similar characteristics.

As of 1999, there are three flow-monitoring stations in operation in the Obed basin; 03539600 Daddys Creek near Hebbertsburg, 03539778 Clear Creek at Lily Bridge near Lancing, and 03539800 Obed River near Lancing. The most downstream site in the basin, 03540500 Emory River at Oakdale, is also in operation. Two of the three forks of the Obed River drainage are monitored as well as the combined flow. Flow from the third fork can be estimated by subtraction or the use of a drainage area ratio. Runoff data from these stations for May 1999 to September 2000 (figure 22) indicates that 03539778 Clear Creek at Lilly Bridge reacts slightly differently than the other sites. Daddys Creek and Obed River proper drain from the vicinity of Crossville, the south side of the basin. Clear Creek drains from the north side of the basin, as does the Emory River above the

Obed River confluence. Additional data and further data analyses would be required to determine if there are significant differences between these sites.

Summary

Surface-water discharge and rainfall data for the Emory River Basin were compiled and analyzed to generate a basic understanding of Obed River and Emory River hydrology. Surface-water data has been collected at an extensive number of sites. This data collection has been for specific projects and efforts, resulting in a data set fragmented over time. Long-term rainfall records are available for two stations in the Obed River headwaters; Crossville Experiment Station (1912 – present) and Crossville Airport (1954 – present). TVA operated raingages have data available from 1986 to present. Due to period of record, the TVA rainfall data was not used in these analyses.

Headwater area populations are growing rapidly. From 1990 to 2000 Fairfield Glade had a 121 percent population increase. Crossville had a 29.6 percent increase. Impoundments in the Obed River headwaters documented by TVA through 1994 cover about 3,820 acres. Area controlled by these impoundments has not been tabulated. Area water supplies come from surface-water impoundments. As of 2000, an average of 3.25 million gallons per day (5.03 cfs) are withdrawn from these sources. Effluent release back into the Obed River system has made up as much as 57 percent of flow past 03539800 Obed River near Lancing, Tennessee (drainage area 518 square miles).

Duration-curve percentiles were examined. There is a statistically significant positive trend in the 0^{th}, 10^{th}, and 30^{th} percentiles for 03540500 Emory River at Oakdale, Tennessee for the 1929 to 2000 period. Plots of these values indicate a change in pattern in the mid-1960's. When tested as 1929 – 1964 and 1965 – 2000 periods, there are no trends. Tests of annual 7-, 14-, and 30-day low flow means also had statistically significant positive trends. Trend tests for high streamflow percentiles (70^{th}, 90^{th}, and 100^{th}) for various time periods produced a mix of results, some positive and some negative.

Trend tests of the rainfall records also showed a mixed result. Crossville Experiment Station has a significant positive trend from 1929 to 1999. Neither Crossville Experiment Station nor Crossville Airport had a significant trend over the 1954 to 1999 period.

Comparison of cumulative rainfall and cumulative runoff indicate that the annual records from 03540500 Emory River at Oakdale, Tennessee and 03539800 Obed River near Lancing, Tennessee have consistent records. No change in accumulation pattern was detected. On a monthly basis, June and October runoff for 03540500 had a significant positive trend. For the Crossville Experiment Station rainfall May and November had significant positive trends.

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Table 1.--Flow station information pulled from 'Baseline water quality data inventory and analysis Obed Wild and Scenic River'

NPS sta.	Lat.	Long.	Agency	Location	FIPS	Storet ID	Cont. Discharge	Instant. Discharge
obri0103	35.890281	84.937781	131tvac	Tn hwy 68 bridge	47035	475135/3599		07/25/67 - 11/02/71
obri0135	35.955837	85.060004	131tvac	above Lake Holiday dam	47035	475411/3578		09/28/67 - 11/02/71
obri0126	35.957505	85.050004	112wrd	Obed R at Crossville	47035	03538600		02/06/92 - 09/20/95
obri0128	35.957505	85.05056	131tvac	above sewage disposal plant	47035	475137/3575		06/23/67 - 11/02/71
obri0131	35.960198	85.051227	11npswrd	Obed R at hwy 70 west bridge	47035	obri_tdph_ob1/obedis01		03/29/79 - 03/29/79
obri0133	35.960837	85.052226	131tvac	below sewage disposal plant	47035	475182/3572		11/07/67 - 11/07/67
obri0132	35.961142	85.051698	11npswrd	Obed R d/s of Crossville WWTP	47035	obri_tdph_ob3/obedis03		03/29/79 - 03/29/79
obri0127	35.961365	85.050532	11npswrd	Obed R nr Crossville WWTP	47035	obri_tdph_ob2/obedis02		03/29/79 - 03/29/79
obri0134	35.96417	85.056392	131tvac	wnw of Crossville	47035	475183/3569		06/23/67 - 11/07/67
obri0123	35.97417	85.048615	112wrd	Obed R nr Crossville	47035	03538618		10/14/75 - 06/16/76
obri0119	35.974365	85.048476	11npswrd	Obed R at U.S. hwy north bridge	47035	obri_tdph_ob4/obedis04		03/29/79 - 03/29/79
obri0121	35.974448	85.048615	131tvac	U.S. hwy 70N bridge, 2.1 mi nw of Crossvile	47035	475184/3563		06/23/67 - 11/07/67
obri0124	35.974448	85.048615	112wrd	Obed R 36.88	47035	355828085025500		06/01/71 - 12/08/76
obri0118	35.978892	85.046392	131tvac	Tennessee Central RR bridge	47035	475185/3560		06/23/67 - 11/07/67
obri0117	35.996753	85.044754	11npswrd	Obed R U.S. hwy 127 bridge	47035	obri_tdph_ob5/obedis05		03/29/79 - 03/29/79
obri0115	35.996948	85.044726	131tvac	Tn hwy 28 bridge 3.4 m nnw of Crossville	47035	475138/3557		06/23/67 - 11/02/71
obri0085	35.997781	84.823616	131tvac		47035	475136/3596		07/25/67 - 11/02/71
obri0084	35.998059	84.823337	112wrd	Daddys Cr nr Hebbertsburg	47035	03539600	05/22/65 - 09/28/65	05/24/79 - 08/18/81
obri0069	36.050837	84.792227	131tvac	Road crossing blw Little Cove Br	47129	475313/3593		09/28/67 - 04/23/68
obri0043	36.051392	84.66806	21tneco	Island Cr quad 122sw bridge crossing	47129	eco68a27		08/05/98 - 12/01/98
obri0041	36.052781	84.666948	112wrd	Island Cr nr Catoosa	47129	03539831		05/23/79 - 08/18/81
obri0042	36.052781	84.667227	112wrd	Island Cr at Catoosa	47129	03539830		05/23/65 - 05/23/65
obri0072	36.058337	84.79306	112wrd	Daddys Cr at DBT	47035	03539690		07/24/96 - 07/24/96
obri066	36.058615	84.791392	21tneco	Daddys Cr rm 2.3 quad 116se	47035	eco68a26		10/17/96 - 11/24/98
obri0067	36.059253	84.79231	11npswrd	Daddys Cr at DBT	47035	obri_dec_dc		10/17/96 - 10/17/96
obri0068	36.059253	84.79231	11npswrd	Daddys Cr at DBT	47035	obri_usfw_d1		06/26/79 - 06/26/79
obri0106	36.06167	84.96167	131tvac	Adams Bridge	47035	475139/3554		06/23/67 - 03/17/76
obri0030	36.067392	84.66117	11npswrd	Emory R blw Nemo Bridge	47129	obri_usfw_e3		06/26/79 - 06/26/79
obri0032	36.068615	84.662504	131tvac	county bridge nr Nemo	47129	475310/3521		09/27/67 - 11/02/71
obri0036	36.06942	84.662949	11npswrd	Rock Cr at confl w Emory R	47129	obri_usfw_r2		06/26/79 - 06/26/79
obri0031	36.070226	84.661449	11npswrd	Emory R u/s of Nemo Bridge	47129	obri_usfw_e2		06/26/79 - 06/26/79
obri0038	36.07042	84.664142	11npswrd	Rock Cr u/s of Nemo Bridge	47129	obri_usfw_r1		06/26/79 - 06/26/79
obri0100	36.072503	84.903059	131tvac	At Potter Ford	47035	475410/3551		09/28/67 - 04/23/68
obri0095	36.072615	84.90292	11npswrd	Obed R at Potters Ford	47035	obri_tdph_ob6/obedis06		03/29/79 - 03/29/79
obri0045	36.072753	84.668976	11npswrd	Rock Cr ab mouth Camp Br	47129	obri_usfw_c1		06/26/79 - 06/26/79
obri0025	36.075531	84.648365	11npswrd	Emory R u/s of Obed R mouth	47129	obri_usfw_e1		06/26/79 - 06/26/79
obri0021	36.07917	84.641948	112wrd	Emory R nr Lancing	47129	03538580		06/26/96 - 06/26/96
obri0046	36.081392	84.670837	112wrd	Obed R nr Lancing	47129	03539800	02/02/65 - 05/23/68	10/08/75 - 08/20/85
obri0010	36.081948	84.576392	112wrd	Crooked Fk Cr 4.22	47129	360455084343500		06/23/67 - 12/13/76
obri0009	36.082226	84.576392	112wrd	Crooked Fk at Wartburg	47129	03539900		10/15/75 - 06/14/76
obri0063	36.083059	84.764615	112wrd	Obed R nr Frankfort	47129	03539700	10/06/65 - 10/06/65	
obri0005	36.084726	84.555005	112wrd	Crooked Fk nr Wartburg	47129	03539860	10/07/65 - 07/29/68	05/24/79 - 08/18/81
obri0004	36.097226	84.548059	21tneco	Flat Fk Quad 122ne	47129	eco69d03		11/12/96 - 11/18/98
obri0050	36.101949	84.716948	112wrd	Clear Cr at Howard Mill	47129	03539780	05/22/65 - 10/06/65	05/22/65 - 10/06/65

Table 1.--Flow station information pulled from 'Baseline water quality data inventory and analysis Obed Wild and Scenic River'

NPS sta.	Lat.	Long.	Agency	Location	FIPS	Storet ID	Cont. Discharge	Instant. Discharge
obri0051	36.101949	84.717227	131tvac		47129	475146/3581		07/28/67 - 04/23/68
obri0015	36.112781	84.615004	112wrd	Emory R nr Wartburg	47129	03538500	05/22/65 - 07/29/68	10/15/75 - 06/09/76
obri0017	36.113059	84.615282	112wrd	Emory R 34.52	47129	360647084365500		06/23/67 - 12/08/76
obri0054	36.119171	84.742505	21tneco	Clear Cr rm 4. Quad 122sw	47129	eco68a08		11/12/96 - 11/14/96
obri0058	36.120281	84.745837	131tvac	Jett Bridge	47129	475314/3584		09/28/67 - 11/02/71
obri0057	36.12056	84.745892	11npswrd	Clear Cr at Jett access	47129	eco68a08		02/06/97 - 01/27/98
obri0059	36.12167	84.746116	112wrd	Clear Cr nr Lancing	47129	03539750	09/06/66 - 06/21/67	05/25/79 - 08/19/81
obri0076	36.122781	84.795004	112wrd	Clear Cr at Waltman Ford Bridge	47129	03539735		07/22/96 - 07/22/96
obri0081	36.124726	84.799448	112wrd	White Cr nr Frankfort	47129	03539730	05/22/65 - 05/22/65	
obri0020	36.132781	84.64167	21tneco	Rock Cr off hwy 62 122nw	47129	eco68a28		08/05/98 - 08/05/98
obri0019	36.133892	84.625281	112wrd	Rock Cr nr Gobey	47129	03538398		05/23/79 - 08/19/81
obri0013	36.149448	84.597226	112wrd	Emory R at Gobey	47129	360858084355000		05/24/79 - 08/18/81
obri0007	36.151392	84.574726	131tvac		47129	475311/3524		09/27/67 - 04/22/68
obri0012	36.160003	84.584727	131tvac	.4 mile nnw of Elizabeth School	47129	475316/3605		09/27/67 - 04/22/68
obri0112	36.16917	85.028059	131tvac	Below D.O. Beaty Bridge	47129	475621/3590		07/06/71 - 11/02/71
obri0082	36.177781	84.800281	112wrd	White Cr at Twin Bridges	47129	03539719		05/24/79 - 08/19/81

Table 2.--Surface water stations in the Emory River Basin.

Number	Latitude	Longitude	Name	Station type	Period of record	Drainage area square miles
03538296	36 09 17	84 35 04	Greasy Creek near Gobey	LFPR	1961-71	13.8
03538296.8	36 08 50	84 35 50	Emory River at Gobey	LFPR	1979-81	43.3
03538297	36 07 40	84 37 00	Emory River northwest of Wartburg	Misc	1973	49.2
03538300	36 11 54	84 39 39	Rock Creek near Sunbright	CSG	1955-71	5.5
03538300	36 11 54	84 39 39	Rock Creek near Sunbright	LFPR, Misc	1955-65	5.5
03538398	36 08 02	84 37 31	Rock Creek near Gobey	LFPR, Misc	1952-81	31.2
03538400	36 07 43	84 37 07	Rock Creek near Wartburg	LFPR	1952-53	31.7
03538500	36 06 46	84 36 54	Emory River near Wartburg	Cont	1934-57, 1966-68	83.2
03538500	36 06 46	84 36 54	Emory River near Wartburg	CSG	1958-65, 1968-82	83.2
03538500	36 06 46	84 36 54	Emory River near Wartburg	Misc	1929-34, 1957-65	83.2
03538580	36 04 25	84 38 57	Emory River near Lancing	Misc	1998, 1999	91.7
03538600	35 57 27	85 03 00	Obed River at Crossville	Cont	1991-95	12.0
03538600	35 57 27	85 03 00	Obed River at Crossville	CSG	1955-91	12.0
03538600	35 57 27	85 03 00	Obed River at Crossville	LFPR	1950-51, 1968	12.0
03538618	35 58 28	85 02 55	Obed River near Crossville	LFPR, Misc	1950, 1968	14.0
03538700	35 58 31	85 02 06	Little Obed River near Crossville	CSG	1955-70	4.7
03538700	35 58 31	85 02 06	Little Obed River near Crossville	Misc	1963	4.7
03538800	35 58 59	85 03 31	Obed River tributary near Crossville	CSG	1955-70	0.7
03538800	35 58 59	85 03 31	Obed River tributary near Crossville	Misc	1963	0.7
03538820	35 59 49	85 02 35	Obed River at Alvin York Highway (US127)	Misc	1968	56.0
03538830	36 03 36	84 57 23	Obed River at Adams Bridge near Crossville	Misc	1999	
03538840	36 03 44	84 57 28	Obed River near Crossville	LFPR, Misc	1954-55	92.4
03538860	36 04 22	84 54 10	Obed River at Potter Ford near Crossville	LFPR, Misc	1955	108.0
03538860	36 04 15	84 54 11	Obed River at Potter Ford near Crossville	Misc	1998-99	107.4
03538871	36 03 16	84 51 21	Otter Creek near Hebbertsburg	LFPR	1954-55	11.4
03538871	36 03 10	84 51 21	Otter Creek near Hebbertsburg	Misc	1999	11.4
03538875	36 05 00	84 49 56	Otter Creek below Hebbertsburg	LFPR	1954	20.1
03538880	36 04 49	84 46 04	Obed River above Daddys Creek near Hebbertsburg	LFPR, Misc	1943, 1953, 1955	156.0
03538900	35 47 54	85 02 33	Self Creek near Big Lick	CSG	1968-85	3.8
03538950	35 48 38	85 01 13	Lick Creek at Big Lick	CSG	1968-74	8.6
03538995	35 50 39	84 59 17	Daddys Creek near Linary	LFPR, Misc	1929, 1952-53	38.7
03539000	35 53 26	84 56 16	Daddys Creek near Grassy Cove	Cont	1925-30	51.2

Station type: Cont = Continuous Record; LFPR = Low flow partial record; CSG = Crest stage gage; Misc = Miscellaneous.

Table 2.--Surface water stations in the Emory River Basin.

Number	Latitude	Longitude	Name	Station type	Period of record	Drainage area square miles
03539000	35 53 26	84 56 17	Daddys Creek near Meridian	Misc	1967	51.2
03539100	35 53 40	85 03 38	Byrd Creek near Crossville	CSG	1968-75	1.1
03539120	35 53 36	85 01 32	Byrd Creek near Crossville	LFPR, Misc	1961-71	5.4
03539300	35 55 24	84 56 08	Byrd Creek near Dorton	Misc	1958	27.9
03539498	35 55 08	84 55 12	Byrd Creek near Crab Orchard	Misc	1925, 1929	29.0
03539500	35 55 33	84 54 47	Daddys Creek near Crab Orchard	Cont	1931-58	93.5
03539600	35 59 53	84 49 24	Daddys Creek near Hebbertsburg	Cont	1957-68, 1999-00	139.0
03539600	35 59 53	84 49 24	Daddys Creek near Hebbertsburg	Misc	1979-81	139.0
03539650	35 59 43	84 49 15	Crabapple Branch near Watson	LFPR	1961-69	5.1
03539685	36 01 09	84 47 40	Yellow Creek at Hebbertsburg	LFPR	1953	15.8
03539690	36 03 25	84 47 34	Daddys Creek at Devils Breakfast Table	Misc	1996, 1999	173.9
03539698	36 04 41	84 46 02	Daddys Creek near Hebbertsburg	LFPR, Misc	1954-56	175.0
03539700	36 04 46	84 45 51	Obed R below Daddys Creek near Frankfort	LFPR, Misc	1954, 1965	331.0
03539700	36 04 46	84 45 50	Obed River near Frankfort	Misc	1998, 1999	
03539710	36 10 12	85 01 42	Clear Creek near Rinnie	Misc	1932	25.6
03539715	36 05 23	85 03 50	No Business Creek at Isoline	LFPR	1961-71	2.8
03539717	36 08 14	84 52 23	Clear Creek at Norris Ford near Jones Knob	Misc	1998-99	81.1
03539719	36 10 40	84 48 01	White Creek at Twin Bridges	LFPR, Misc	1979-81	38.4
03539720	36 09 31	84 47 20	White Creek near Twin Bridges	LFPR, Misc	1961-71	45.0
03539730	36 07 29	84 47 58	White Creek near Frankfort	Misc	1979	50.5
03539731	36 07 16	84 47 50	White Creek above mouth near Deerlodge	Misc	1999	
03539735	36 07 14	84 47 43	Clear Creek at Barnett Bridge near Deerlodge	Misc	1998-99	145.9
03539748	36 07 44	84 43 19	Little Clear Creek near Howard Mill	LFPR	1953	10.5
03539750	36 07 18	84 44 46	Clear Creek near Lancing (Jett Bridge)	Cont	1966-68	153.0
03539750	36 07 18	84 44 46	Clear Creek near Lancing (Jett Bridge)	LFPR, Misc	1953, 1979-81	153.0
03539778	36 06 11	84 43 06	Clear Creek at Lilly Bridge near Lancing	Cont	1997-00	170.0
03539780	36 06 07	84 43 01	Clear Creek at Howard Mill (Lilly Bridge)	LFPR, Misc	1955, 1965	170.0
03539800	36 04 53	84 40 15	Obed River near Lancing	Cont	1957-68, 1973-87, 1999-00	518.0
03539810	36 04 33	84 39 00	Obed River near Wartburg	Misc	1939	520.0
03539818	36 04 07	84 39 52	Rock Creek above mouth near Wartburg	Misc	1999	
03539820	36 04 09	84 39 46	Emory River near Nemo	Misc	1955	612.0
03539820	36 04 02	84 39 44	Emory River near Nemo	Misc	1999	612.0

Station type: Cont = Continuous Record; LFPR = Low flow partial record; CSG = Crest stage gage; Misc = Miscellaneous.

Table 2.--Surface water stations in the Emory River Basin.

Number	Latitude	Longitude	Name	Station type	Period of record	Drainage area square miles
03539860	36 05 05	84 33 18	Crooked Fork near Wartburg	Cont	1966-68	50.3
03540000	36 01 39	84 34 47	Emory River at Deermont	Cont	1920-28	704.0
03540100	36 00 40	84 36 44	Crab Orchard Creek near Deermont	Cont	1966-68	33.7
03540500	35 58 59	84 33 29	Emory River at Oakdale	Cont	1927-00	764.0

Station type: Cont = Continuous Record; LFPR = Low flow partial record; CSG = Crest stage gage; Misc = Miscellaneous.

Table 3.--Continuous record surface water stations in the Emory River Basin with significant periods of record.

Period	Number	Name	Years	Drainage area (sq.mi.)
pre1976	03538500	Emory River near Wartburg	1934-57, 1966-68	83.2
post1976	03538600	Obed River at Crossville	1991-95	12.0
pre1976	03539500	Daddys Creek near Crab Orchard	1931-58	93.5
pre1976	03539600	Daddys Creek near Hebbertsburg	1957-68	139.0
post1976	03539600	Daddys Creek near Hebbertsburg	1999-00	139.0
post1976	03539778	Clear Creek at Lilly Bridge near Lancing	1997-00	170.0
pre1976	03539800	Obed River near Lancing	1957-68, 1973-76	518.0
post1976	03539800	Obed River near Lancing	1976-87, 1999-00	518.0
pre1976	03540000	Emory River at Deermont	1920-28	704.0
pre1976	03540500	Emory River at Oakdale	1927-76	764.0
post1976	03540500	Emory River at Oakdale	1976-00	764.0

Table 4.--Discharges for selected recurrence interval floods at Emory River Basin gages (from Weaver and Gamble, 1993).

Station	Name	Drainage area, sq. mi.	Peak discharge, in cubic feet per second for indicated recurrence interval.						
			2-year	5-year	10-year	25-year	50-year	100-year	500-year
03538500	Emory River near Wartburg	83.20	6,740	10,400	13,200	17,100	20,200	23,400	32,700
03538600	Obed River at Crossville	12.00	667	955	1,170	1,460	1,690	1,930	2,520
03538800	Obed River tributary near Crossville	0.72	132	203	258	338	405	471	684
03538900	Self Creek near Big Lick	3.80	280	542	775	1,140	1,470	1,800	2,960
03539500	Daddys Creek near Crab Orchard	93.50	4,760	7,460	9,310	11,700	13,500	15,500	19,600
03539600	Daddys Creek near Hebbertsburg	139.00	7,420	8,990	10,100	11,600	12,700	14,100	16,900
03539800	Obed River near Lancing	518.00	30,400	44,300	52,600	62,300	69,100	79,300	90,100
03540500	Emory River at Oakdale	764.00	45,000	71,000	89,300	113,000	132,000	154,000	199,000

Table 5.--Low-flow information for sites in the Emory River Basin.(Outlaw and Weaver, 1996)

Station	Name	Gage type	Period of record	Drainage area, in sq.mi.	7Q10, in cfs
03538500	Emory River near Wartburg	Continuous	1935-68	83.2	0.00
03539000	Daddys Creek near Grassy Cove	Continuous	1926-30	51.2	0.00
03539500	Daddys Creek near Crab Orchard	Continuous	1931-58	93.5	0.00
03539600	Daddys Creek near Hebbertsburg	Continuous	1958-68	139.0	0.50
03539800	Obed River near Lancing	Continuous	1958-68, 1974-87	518.0	1.30
03540000	Emory River at Deermont	Continuous	1921-27	704.0	4.00
03540500	Emory River at Oakdale	Continuous	1928-92	764.0	0.68

Table 6.--Precipitation records available for the Emory River Basin.

Station	Lat.	Long.	Name	Period of record	Agency	Comment
03538900	35 47 54	85 02 33	Self Creek near Big Lick	1967-75	USGS	Not to be used
03538950	35 48 38	85 01 13	Lick Creek at Big Lick	1966-71	USGS	Not to be used
03539100	35 53 40	85 03 38	Byrd Creek near Crossville	1971-75	USGS	Not to be used
699	35 48 46	85 02 10	Big Lick	1986-00	TVA	
163	35 54 41	84 53 22	Crab Orchard	1986-00	TVA	
417	35 57 08	85 05 05	Crossville Airport	1986-00	TVA	
418	36 06 34	84 48 27	Frankfort	1986-00	TVA	
800	36 04 41	85 03 42	Isoline	1986-00	TVA	
167	36 05 56	84 26 46	Petros	1986-00	TVA	
485	36 14 56	84 39 40	Sunbright	1986-00	TVA	
736	36 06 50	84 36 14	Wartburg	1986-00	TVA	
8766	36 14 57	84 41 49	Sunbright1W	1948-51	NCDC	
5040	36 09 03	84 43 46	Lancing6NW	1989-99	NCDC	
2197	35 57 15	85 04 57	Crossville Airport	1954-99	NCDC	
2202	36 00 53	85 07 52	Crossville Experiment Station	1912-99	NCDC	

Table 7.--Population summary for Cumberland County, Morgan County, Fairfield Glade, and Crossville.								
Year	Cumberland	Increase	Morgan	Increase	Fairfield Glade	Increase	Crossville	Increase
1970	20,716		13,608					
1980	28,676	38.4 %	16,604	22.0 %				
1990	34,736	21.1 %	17,300	4.2 %	2,209		6,930	
2000	46,802	34.7 %	19,757	14.2 %	4,885	121 %	8,981	29.6 %
Base data from U.S. Census Bureau								

Table 8.--Impoundment summary for the Obed River Basin.

Subbasin	Drainage area, sq.mi.	Time block	Number of ponds added	Impoundment surface area acres	Impoundment surface area sq.mi.
Daddys Creek	175	1943-1975	38	122	0.19
	175	1976-87	278	895	1.40
	175	1988-94	743	752	1.18
Subtotal	175		1,059	1,769	2.76
Clear Creek	173	1943-75	133	99	0.15
	173	1976-87	246	250	0.39
	173	1988-94	549	250	0.39
Subtotal	173		928	599	0.94
Obed River	172	1943-75	214	300	0.47
	172	1976-87	222	447	0.70
	172	1988-94	479	705	1.10
Subtotal	172		915	1,452	2.27
Full basin	520	1943-75	385	521	0.81
	520	1976-87	746	1,592	2.49
	520	1988-94	1,771	1,707	2.67
Totals	**520**		**2,902**	**3,820**	**5.97**

Table 9.--Water withdrawal by public utilities in the Obed River headwaters.

Year	Water system	Average annual withdrawal, mgd	Source	River basin
1988	Crossville Water Department	2.55	Holiday Hills Lake	Obed River
1988	Crossville Water Department	0.46	Meadow Park Lake	Caney Fork
1995	Crossville Water Department	1.91	Holiday Hills Lake	Obed River
1995	Crossville Water Department	3.13	Meadow Park Lake	Caney Fork
1995	Crab Orchard Utility District	0.885	Otter Creek Impoundment	Obed River
2000	Crossville Water Department	1.84	Holiday Hills Lake	Obed River
2000	Crossville Water Department	1.09	Meadow Park Lake	Caney Fork
2000	Crab Orchard Utility District	1.41	Otter Creek Impoundment	Obed River

Table 10.--Effluent releases from Crossville and Fairfield Glades waste water treatment facilities.									
		Fairfield Glades		Crossville		03539600	03539800	03539600	03539800
Year	Month	Average effluent release		Average effluent release		average flow, cfs	average flow, cfs	percent effluent	percent effluent
		MGD	CFS	MGD	CFS				
1995	1			2.4576	3.80				
1995	2			1.8317	2.83				
1995	3			1.8984	2.94				
1995	4			1.3062	2.02				
1995	5			1.9252	2.98				
1995	6			1.3549	2.10				
1995	7			1.2096	1.87				
1995	8			0.9807	1.52				
1995	9			1.1288	1.75				
1995	10			1.6354	2.53				
1995	11			2.1706	3.36				
1995	12			1.7657	2.73				
1996	1	0.3490	0.54	2.9190	4.52				
1996	2	0.6710	1.04	2.2383	3.46				
1996	3	0.4400	0.68	2.8228	4.37				
1996	4	0.3890	0.60	1.7361	2.69				
1996	5	0.4700	0.73	2.1513	3.33				
1996	6	0.3800	0.59	1.9707	3.05				
1996	7	0.3610	0.56	2.3420	3.62				
1996	8	0.3910	0.60	2.0519	3.17				
1996	9	0.2930	0.45	1.4540	2.25				
1996	10	0.2800	0.43	1.5172	2.35				
1996	11	0.3620	0.56	2.5625	3.96				
1996	12	0.3900	0.60	2.8693	4.44				
1997	1	0.3730	0.58	3.4663	5.36				
1997	2	0.2840	0.44	3.1934	4.94				
1997	3	0.4730	0.73	3.1556	4.88				
1997	4	0.3870	0.60	2.0017	3.10				
1997	5	0.4400	0.68	2.7952	4.32				
1997	6	0.5050	0.78	3.2222	4.98				
1997	7	0.3680	0.57	1.3288	2.06				
1997	8	0.3460	0.54	1.2239	1.89				

Table 10.--Effluent releases from Crossville and Fairfield Glades waste water treatment facilities.									
		Fairfield Glades		Crossville		03539600	03539800	03539600	03539800
Year	Month	Average effluent release		Average effluent release		average flow, cfs	average flow, cfs	percent effluent	percent effluent
		MGD	CFS	MGD	CFS				
1997	9	0.2930	0.45	1.3270	2.05				
1997	10	0.2860	0.44	1.3532	2.09				
1997	11	0.3050	0.47	2.1546	3.33				
1997	12	0.2760	0.43	2.3530	3.64				
1998	1	0.3220	0.50	3.3214	5.14				
1998	2	0.3750	0.58	3.5008	5.42				
1998	3	0.3590	0.56	2.6197	4.05				
1998	4	0.4380	0.68	2.9050	4.49				
1998	5	0.4200	0.65	2.1059	3.26				
1998	6	0.4790	0.74	2.9715	4.60				
1998	7	0.3990	0.62	1.4883	2.30				
1998	8	0.4100	0.63	1.6739	2.59				
1998	9	0.3470	0.54	1.1676	1.81				
1998	10	0.3020	0.47	1.2398	1.92				
1998	11	0.2570	0.40	1.0893	1.69				
1998	12	0.3040	0.47	2.6525	4.10				
1999	1	0.3930	0.61	3.6874	5.70				
1999	2	0.3210	0.50	2.7025	4.18				
1999	3	0.3580	0.55	2.8579	4.42		1866.00		0.27
1999	4	0.4000	0.62	2.2628	3.50		852.00		0.48
1999	5	0.3870	0.60	2.2461	3.47	494.00	1529.00	0.12	0.27
1999	6	0.3890	0.60	2.0574	3.18	145.00	545.00	0.42	0.69
1999	7	0.4230	0.65	3.0892	4.78	532.00	1843.00	0.12	0.29
1999	8	0.3200	0.50	1.3246	2.05	12.80	47.30	3.87	5.38
1999	9	0.2710	0.42	1.4393	2.23	2.48	5.28	16.90	50.11
1999	10	0.2730	0.42	1.3257	2.05	4.30	9.40	9.82	26.31
1999	11	0.2530	0.39	1.2922	2.00	14.80	29.70	2.64	8.05
1999	12	0.2070	0.32	1.7059	2.64	53.50	132.00	0.60	2.24
2000	1	0.2890	0.45	2.3640	3.66	188.00	568.00	0.24	0.72
2000	2	0.3830	0.59	2.8103	4.35	359.00	1216.00	0.17	0.41
2000	3	0.4620	0.71	2.9540	4.57	446.00	1525.00	0.16	0.35
2000	4	0.5280	0.82	3.2995	5.10	636.00	2283.00	0.13	0.26

Table 10.--Effluent releases from Crossville and Fairfield Glades waste water treatment facilities.

		Fairfield Glades		Crossville		03539600	03539800	03539600	03539800
Year	Month	Average effluent release		Average effluent release		average flow, cfs	average flow, cfs	percent effluent	percent effluent
		MGD	CFS	MGD	CFS				
2000	5	0.4550	0.70	2.3416	3.62	74.50	384.00	0.94	1.13
2000	6	0.4650	0.72	1.8941	2.93	175.00	288.00	0.41	1.27
2000	7	0.4590	0.71	1.7178	2.66	35.40	76.80	2.01	4.38
2000	8	0.4310	0.67	1.6049	2.48	24.60	62.90	2.71	5.01
2000	9	0.3610	0.56	1.1342	1.75	5.37	13.30	10.40	17.39
2000	10	0.3440	0.53	1.1598	1.79	2.07	4.05	25.71	57.44
2000	11	0.3260	0.50	1.8303	2.83	12.50	36.00	4.03	9.27
2000	12	0.3170	0.49	2.2086	3.42	191.00	520.00	0.26	0.75
2001	1	0.3500	0.54	2.4802	3.84	346.00	1098.00	0.16	0.40
2001	2	0.5220	0.81	3.4220	5.29	801.00	2887.00	0.10	0.21
2001	3	0.4320	0.67	2.5375	3.93	251.00	966.00	0.27	0.48
2001	4	0.4920	0.76	2.1051	3.26	241.00	826.00	0.32	0.49
2001	5	0.4300	0.67	1.6666	2.58	34.70	256.00	1.92	1.27
2001	6	0.4430	0.69	1.7424	2.70	20.00	82.70	3.43	4.09
2001	7	0.4670	0.72	1.6877	2.61	30.90	96.60	2.34	3.45
2001	8	0.4880	0.75	1.9634	3.04	54.00	260.00	1.40	1.46
2001	9	0.4260	0.66	1.6269	2.52	8.23	29.60	8.01	10.73
2001	10	0.3750	0.58	1.4876	2.30	8.74	21.40	6.64	13.46
2001	11	0.3640	0.56	1.6410	2.54	54.40	146.00	1.04	2.12
2001	12	0.4160	0.64	2.7184	4.21	273.00	833.00	0.24	0.58
2002	1	0.3680	0.57	3.0190	4.67	953.00	3491.00	0.06	0.15
2002	2	0.3440	0.53	2.5821	3.99	233.00	895.00	0.23	0.51
2002	3	0.4100	0.63	3.1144	4.82	745.00	2730.00	0.09	0.20
2002	4	0.4390	0.68	2.5575	3.96	359.00	1550.00	0.19	0.30

Table 11.--Flow duration for station period-of-record for discharge stations in the Emory River Basin.

Flow in cfs and csm which was equaled or exceeded for percentage of time shown.

	Obed R Crossville		Emory R nr Wartburg		Daddys Cr nr Crab Orchard		Daddys Cr nr Hebbertsburg		Clear Cr nr Lilly Bridge		Obed R nr Lancing		Emory R Oakdale	
	Flow for 03538600		Flow for 03538500		Flow for03539500		Flow for 03539600		Flow for 03539778		Flow for 03539800		Flow for 03540500	
Percent	cfs	csm	cfs	csm	cfs	csm	cfs	csm	cfs	csm	cfs	csm	cfs	csm
99.5	0.29	0.0242	0	0.0000	0.04	0.0004	0.35	0.0025	0.25	0.0015	1.20	0.0023	0.84	0.0011
99.1	0.33	0.0275	0	0.0000	0.06	0.0006	0.46	0.0033	0.32	0.0019	1.60	0.0031	1.52	0.0020
99.0	0.35	0.0292	0	0.0000	0.07	0.0007	0.48	0.0035	0.34	0.0020	1.70	0.0033	1.66	0.0022
98.0	0.44	0.0367	0	0.0000	0.17	0.0018	0.84	0.0060	0.54	0.0032	3.10	0.0060	3.56	0.0047
95.0	0.67	0.0558	0.16	0.0019	0.44	0.0047	2.03	0.0146	1.11	0.0065	10.1	0.0195	8.59	0.0112
90.0	0.95	0.0792	0.69	0.0083	0.95	0.0102	4.65	0.0335	2.30	0.0135	21.5	0.0415	21.0	0.0275
80.0	1.60	0.1333	3.21	0.0386	3.19	0.0341	12.8	0.0921	6.46	0.0380	53.9	0.1041	62.2	0.0814
70.0	2.26	0.1883	9.09	0.1093	9.40	0.1005	28.7	0.2065	12.3	0.0724	116	0.2239	140	0.1832
60.0	3.41	0.2842	20.8	0.2500	24.8	0.2652	60.4	0.4345	30.6	0.1800	235	0.4537	296	0.3874
50.0	5.47	0.4558	41.0	0.4928	54.1	0.5786	105	0.7554	78.9	0.4641	416	0.8031	564	0.7382
40.0	9.44	0.7867	72.0	0.8654	96.6	1.0332	159	1.1439	146	0.8588	648	1.2510	910	1.1911
30.0	18.8	1.5667	113	1.3582	154	1.6471	236	1.6978	236	1.3882	962	1.8571	1350	1.7670
20.0	34.0	2.8333	180	2.1635	250	2.6738	351	2.5252	357	2.1000	1450	2.7992	2041	2.6715
10.0	61.3	5.1083	343	4.1226	436	4.6631	620	4.4604	615	3.6176	2520	4.8649	3510	4.5942
5.0	95.4	7.9500	588	7.0673	706	7.5508	993	7.1439	998	5.8706	3980	7.6834	5670	7.4215
2.0	169	14.0833	1090	13.1010	1200	12.8342	1820	13.0935	1850	10.8824	6420	12.3938	10200	13.3508
1.0	243	20.2500	1750	21.0337	1760	18.8235	2630	18.9209	2970	17.4706	10000	19.3050	15200	19.8953
0.5	374	31.1667	2590	31.1298	2400	25.6684	3510	25.2518	5440	32.0000	13800	26.6409	24600	32.1990
Drainage area mi2	12		83.2		93.5		139		170		518		764	
Period of record	1991-95		1934-57		1931-58		1957-68		1998-2000		1958-68		1928-2000	
			1966-68								1974-87			

03538600 Obed R at Crossville, TN above waste water treatment plant.

03538500 Emory R nr Wartburg, TN

03539500 Daddys Cr nr Crab Orchard, TN

03539600 Daddys Cr nr Hebbertsburg, TN

03539778 Clear Cr at Lilly Bridge nr Lancing, TN

03539800 Obed R nr Lancing, TN

03540500 Emory R at Oakdale, TN

include D.A.

plot?

Table 12.--Flow duration for pre- and post-76 periods of record . Flow in cfs and csm which was equaled or exceeded for percentage of time shown.

Percent	Flow for 03539800						Flow for 03540500							
of time	1958-68 and 1974-87		1958-76		1977-87		1928-00		1928-76		1958-76		1977-2000	
	cfs	csm	cfs	csm	cfs	csm	cfs	csm	cfs	csm	cfs	csm	cfs	csm
99.5	1.20	0.0023	1.19	0.0023	1.23	0.0024	0.84	0.0011	0.48	0.0006	2.94	0.0038	5.24	0.0069
99.1	1.60	0.0031	1.27	0.0025	1.61	0.0031	1.52	0.0020	1.03	0.0013	4.17	0.0055	6.06	0.0079
99.0	1.70	0.0033	1.74	0.0034	1.70	0.0033	1.66	0.0022	1.16	0.0015	4.47	0.0059	6.27	0.0082
98.0	3.10	0.0060	3.00	0.0058	3.53	0.0068	3.56	0.0047	2.33	0.0030	7.60	0.0099	8.02	0.0105
95.0	10.1	0.0195	11.3	0.0218	8.56	0.0165	8.59	0.0112	6.69	0.0088	17.6	0.0230	15.4	0.0202
90.0	21.5	0.0415	23.2	0.0448	18.7	0.0361	21.0	0.0275	17.2	0.0225	33.7	0.0441	29.9	0.0391
80.0	53.9	0.1041	59.7	0.1153	48.3	0.0932	62.2	0.0814	53.9	0.0705	84.7	0.1109	77.9	0.1020
70.0	116	0.2239	121	0.2336	105	0.2027	140	0.1832	124	0.1623	174	0.2277	177	0.2317
60.0	235	0.4537	242	0.4672	228	0.4402	296	0.3874	259	0.3390	345	0.4516	371	0.4856
50.0	416	0.8031	423	0.8166	406	0.7838	564	0.7382	518	0.6780	642	0.8403	649	0.8495
40.0	648	1.2510	666	1.2857	623	1.2027	910	1.1911	881	1.1531	1,020	1.3351	970	1.2696
30.0	962	1.8571	976	1.8842	928	1.7915	1,350	1.7670	1,340	1.7539	1,470	1.9241	1,380	1.8063
20.0	1,450	2.7992	1,610	3.1081	1,360	2.6255	2,041	2.6715	2,020	2.6440	2,150	2.8141	2,030	2.6571
10.0	2,520	4.8649	2,640	5.0965	2,350	4.5367	3,510	4.5942	3,600	4.7120	3,520	4.6073	3,490	4.5681
5.0	3,980	7.6834	4,110	7.9344	3,700	7.1429	5,670	7.4215	5,680	7.4346	5,780	7.5654	5,650	7.3953
2.0	6,420	12.3938	7,280	14.0541	6,470	12.4903	10,200	13.3508	9,990	13.0759	10,300	13.4817	9,830	12.8665
1.0	10,000	19.3050	10,600	20.4633	8,810	17.0077	15,200	19.8953	15,100	19.7644	15,000	19.6335	14,100	18.4555
0.5	13,800	26.6409	14,600	28.1853	12,000	23.1660	24,600	32.1990	21,900	28.6649	20,500	26.8325	22,300	29.1885
Drainage area mi2	518		518		518		764		764		764		764	

03539800 Obed River near Lancing, TN

03540500 Emory River at Oakdale, TN

Table 13.--Kendall trend analysis for 0th, 10th, and 30th percentiles of streamflow for gages in the Emory River Basin.					
Station number	Station name	Time period	Kendall tau	p-value	Trend slope ft3/s/yr
Annual minimum (daily mean value), 0th percentile					
03538500	Emory River near Wartburg, TN	1935-57	-0.16	0.2596	0.000
03539500	Daddys Creek near Crab Orchard, TN	1931-58	-0.14	0.3028	-0.005
03539600	Daddys Creek near Hebbertsburg, TN	1958-68	0.02	1.0000	0.033
03539800	Obed River near Lancing, TN	1958-87	0.01	0.9441	0.008
		1958-68	0.14	0.5846	0.200
		1974-87	-0.19	0.3811	-0.400
03540500	Emory River at Oakdale, TN	1929-00	0.30	0.0002	0.108
		1929-64	0.08	0.5310	0.037
		1965-00	-0.17	0.1410	-0.240
		1929-75	0.30	0.0030	0.175
		1976-00	0.00	1.0000	0.000
		1958-68	0.20	0.4363	1.040
		1958-87	0.02	0.8864	0.017
		1974-87	-0.11	0.6217	-0.156
Annual 10th percentile (daily mean value)					
03538500	Emory River near Wartburg, TN	1935-57	-0.10	0.5255	-0.026
03539500	Daddys Creek near Crab Orchard, TN	1931-58	-0.09	0.5015	-0.017
03539600	Daddys Creek near Hebbertsburg, TN	1958-68	0.13	0.6404	0.148
03539800	Obed River near Lancing, TN	1958-87	-0.12	0.4003	-0.314
		1958-68	0.02	1.0000	0.167
		1974-87	-0.16	0.4434	-0.444
03540500	Emory River at Oakdale, TN	1929-00	0.18	0.0253	0.274
		1929-64	0.41	0.7334	0.095
		1965-00	-0.14	0.2359	-0.619
		1929-75	0.22	0.0311	0.583
		1976-00	-0.09	0.5591	-0.392
		1958-68	0.07	0.8148	1.000
		1958-87	0.00	1.0000	0.000
		1974-87	-0.03	0.9218	-0.371

Table 13.--Kendall trend analysis for 0th, 10th, and 30th percentiles of streamflow for gages in the Emory River Basin.					
Station number	Station name	Time period	Kendall tau	p-value	Trend slope ft3/s/yr
Annual 30th percentile (daily mean value)					
03538500	Emory River near Wartburg, TN	1935-57	-0.04	0.7916	-0.070
03539500	Daddys Creek near Crab Orchard, TN	1931-58	0.10	0.4646	0.178
03539600	Daddys Creek near Hebbertsburg, TN	1958-68	-0.13	0.6404	-0.689
03539800	Obed River near Lancing, TN	1958-87	-0.05	0.7614	-0.667
		1958-68	-0.09	0.7555	-2.828
		1974-87	-0.08	0.7426	-2.087
03540500	Emory River at Oakdale, TN	1929-00	0.23	0.0051	1.595
		1929-64	0.08	0.4958	0.764
		1965-00	-0.08	0.5132	-1.187
		1929-75	0.22	0.0334	2.023
		1976-00	-0.23	0.1176	-4.979
		1958-68	0.02	1.0000	0.229
		1958-87	0.08	0.5560	1.773
		1974-87	-0.16	0.4434	-6.350

Table 14.--Kendall trend analysis of 7-, 14-, and 30-day low streamflow duration for 03540500 Emory River at Oakdale, Tennessee						
Time period	Kendall tau	p-value	Trend slope ft3/s/yr			
7-day						
1929 - 2000	0.25	0.0016	0.152			
14-day						
1929 - 2000	0.24	0.0032	0.194			
30-day						
1929 - 2000	0.20	0.0125	0.264			

Table 15.--Kendall trend analysis for 70th, 90th, and 100th percentiles of streamflow for gages in the Emory River Basin.

Station number	Station name	Time period	Kendall tau	p-value	Trend slope ft3/s/yr
Annual 70th percentile					
03538500	Emory River near Wartburg, TN	1935-57	0.59	0.7116	0.389
03539500	Daddys Creek near Crab Orchard, TN	1931-58	0.12	0.3846	1.209
03539600	Daddys Creek near Hebbertsburg, TN	1958-68	-0.42	0.0868	-12.125
03539800	Obed River near Lancing, TN	1958-87	-0.09	0.5593	-3.216
		1958-68	-0.20	0.4363	-24.200
		1974-87	-0.45	0.0285	-45.298
03540500	Emory River at Oakdale, TN	1929-00	0.16	0.0431	5.338
		1929-64	0.11	0.3335	6.855
		1965-00	0.03	0.8381	2.236
		1929-75	0.22	0.0334	10.185
		1976-00	0.33	0.8335	5.389
		1958-68	-0.20	0.4363	-43.333
		1958-87	-0.03	0.8028	-4.000
		1974-87	-0.42	0.0375	-53.250
Annual 90th percentile					
03538500	Emory River near Wartburg, TN	1935-57	0.16	0.2908	2.500
03539500	Daddys Creek near Crab Orchard, TN	1931-58	0.14	0.3229	2.309
03539600	Daddys Creek near Hebbertsburg, TN	1958-68	-0.20	0.4363	-12.520
03539800	Obed River near Lancing, TN	1958-87	-0.06	0.6913	-4.458
		1958-68	-0.05	0.8763	-4.000
		1974-87	-0.28	0.1889	-101.853
03540500	Emory River at Oakdale, TN	1929-00	0.05	0.5054	4.132
		1929-64	0.09	0.4375	10.421
		1965-00	0.10	0.4216	18.799
		1929-75	0.08	0.4411	9.250
		1976-00	0.08	0.5911	21.770
		1958-68	-0.13	0.6404	-42.700
		1958-87	-0.01	0.9431	-5.222
		1974-87	-0.30	0.1546	-126.000

Table 15.--Kendall trend analysis for 70th, 90th, and 100th percentiles of streamflow for gages in the Emory River Basin.

Station number	Station name	Time period	Kendall tau	p-value	Trend slope ft3/s/yr
Annual 100th percentile					
03538500	Emory River near Wartburg, TN	1935-57	0.20	0.1955	68.000
03539500	Daddys Creek near Crab Orchard, TN	1931-58	0.31	0.0208	92.292
03539600	Daddys Creek near Hebbertsburg, TN	1958-68	-0.09	0.7555	-33.333
03539800	Obed River near Lancing, TN	1958-87	-0.14	0.3383	-155.097
		1958-68	-0.27	0.2758	-650.000
		1974-87	-0.34	0.1005	-1460.372
03540500	Emory River at Oakdale, TN	1929-00	0.09	0.2870	73.333
		1929-64	0.23	0.0498	438.194
		1965-00	0.06	0.6238	92.262
		1929-75	0.17	0.1006	267.105
		1976-00	0.05	0.7614	147.222
		1958-68	-0.38	0.1195	-1377.778
		1958-87	-0.11	0.4017	-391.666
		1974-87	-0.34	0.1005	-2150.000
		1931-58	0.33	0.0151	796.667

Table 16.--Kendall trend analysis for rainfall records; Crossville Experiment Station and Crossville Airport.

Station name	Time period	Kendall tau	p-value	Trend slope inches/yr
Crossville Experiment Station	1915-99	0.18	0.0129	0.117
	1929-99	0.26	0.0012	0.186
	1955-99	0.08	0.4168	0.094
Crossville Airport	1955-99	0.07	0.5312	0.046

Table 17.-- Annual yields (runoff/rainfall) for stations in the Obed/Emory Watershed.

Station number	Station name	Mean yield	Number of years
03538500	Emory River near Wartburg	0.43	23
03538600	Obed River at Crossville	0.48	3
03539500	Daddys Creek near Crab Orchard	0.46	28
03539600	Daddys Creek near Hebbertsburg	0.49	11
03539778	Clear Creek at Lilly Bridge near Lancing	0.42	2
03539800	Obed River near Lancing	0.49	25
03540500	Emory River at Oakdale	0.46	72

Table 18.--Summary statistics for Crossville Experiment Station and Crossville Airport rainfall data for May 1954 to December 1999.

	October		November		December		January		February		March		April		May		June		July		August		September	
	cexp	cap	cexp	cap	cexp	cap	cexp	cap	cexp	cap	cexp	cap	cexp	cap	cexp	cap	cexp	cap	cexp	cap	cexp	cap	cexp	cap
Minimum	0.00	0.00	1.78	1.68	0.81	0.94	1.32	0.79	1.07	0.84	2.40	1.95	1.44	1.59	1.84	1.38	0.96	0.87	1.06	0.90	1.16	0.91	0.39	0.66
1st Quartile	1.94	1.92	3.62	3.10	3.87	3.62	3.55	3.05	3.66	3.37	4.42	4.22	3.43	3.31	3.65	3.74	2.94	2.82	3.34	2.94	2.62	2.39	2.55	2.00
Mean	3.60	3.21	4.94	4.80	5.86	5.46	5.34	4.86	5.06	4.58	6.39	6.12	5.08	4.86	5.31	5.01	4.76	4.57	5.17	5.00	3.80	3.99	3.99	3.72
Median	3.33	2.92	4.56	4.64	4.80	4.71	4.99	4.41	4.79	4.43	5.65	5.23	4.62	4.50	4.70	4.58	4.02	4.76	4.50	4.71	3.33	3.72	3.82	3.54
3rd Quartile	5.08	4.49	5.91	5.81	7.80	7.13	6.68	6.66	6.15	5.56	7.70	7.70	6.03	6.26	6.40	5.98	6.67	5.86	6.42	6.41	5.25	5.37	5.11	5.10
Maximum	8.66	7.20	9.78	10.89	16.73	12.75	10.97	10.20	10.93	9.14	16.52	15.34	11.26	11.26	14.99	10.84	13.09	14.15	13.25	11.95	8.29	9.35	8.86	9.00
N	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00
Variance	3.82	3.40	4.05	4.63	9.98	7.06	5.70	5.80	5.26	3.42	9.88	9.47	5.11	5.75	6.40	4.07	7.56	7.09	6.03	7.48	2.67	4.09	4.20	4.14
Std Dev	1.96	1.84	2.01	2.15	3.16	2.66	2.39	2.41	2.29	1.85	3.14	3.08	2.26	2.40	2.53	2.02	2.75	2.66	2.46	2.74	1.63	2.02	2.05	2.03
SE Mean	0.29	0.27	0.30	0.32	0.47	0.39	0.36	0.36	0.34	0.28	0.47	0.46	0.34	0.36	0.37	0.30	0.41	0.39	0.36	0.40	0.24	0.30	0.30	0.30

cexp Crossville Experiment Station

cap Crossville Airport

Table 19.--Kendall trend analysis for monthly runoff for 03540500 Emory River at Oakdale and Crossville Experiment Station, concomitant period of record.

	Emory River runoff				Crossville Experiment Station rainfall		
Month	Kendall tau	p-value	Trend slope inches/yr		Kendall tau	p-value	Trend slope inches/yr
January	0.11	0.1735	0.018		0.14	0.0944	0.023
February	-0.08	0.3506	-0.012		-0.05	0.5219	-0.008
March	-0.02	0.8496	-0.002		0.07	0.3959	0.012
April	-0.05	0.5499	-0.004		0.06	0.4871	0.008
May	0.08	0.3285	0.007		0.25	0.0025	0.035
June	0.21	0.0083	0.008		0.08	0.3089	0.014
July	0.08	0.2980	0.002		0.03	0.6913	0.005
August	0.03	0.6828	0.000		-0.02	0.8310	-0.003
September	0.09	0.2818	0.001		0.09	0.2792	0.013
October	0.22	0.0064	0.002		0.10	0.2261	0.014
November	0.14	0.0838	0.007		0.20	0.0121	0.029
December	0.07	0.3530	0.012		0.11	0.1557	0.019

Figure 1.—Box plots of annual rainfall (water year) for respective periods of record.

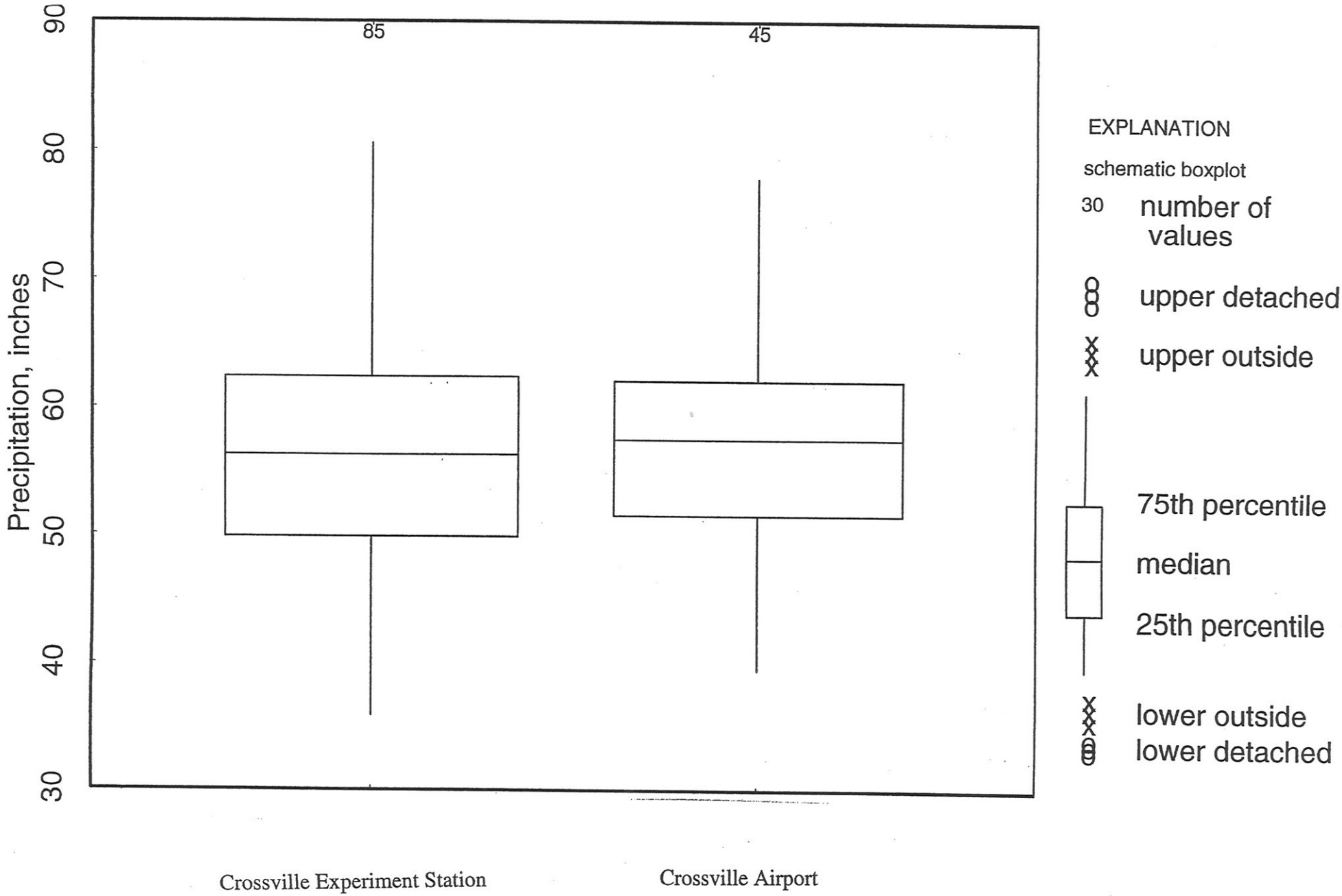


Figure 2.--Water year rainfall totals for Crossville Experiment Station and Crossville Airport for respective periods of record.

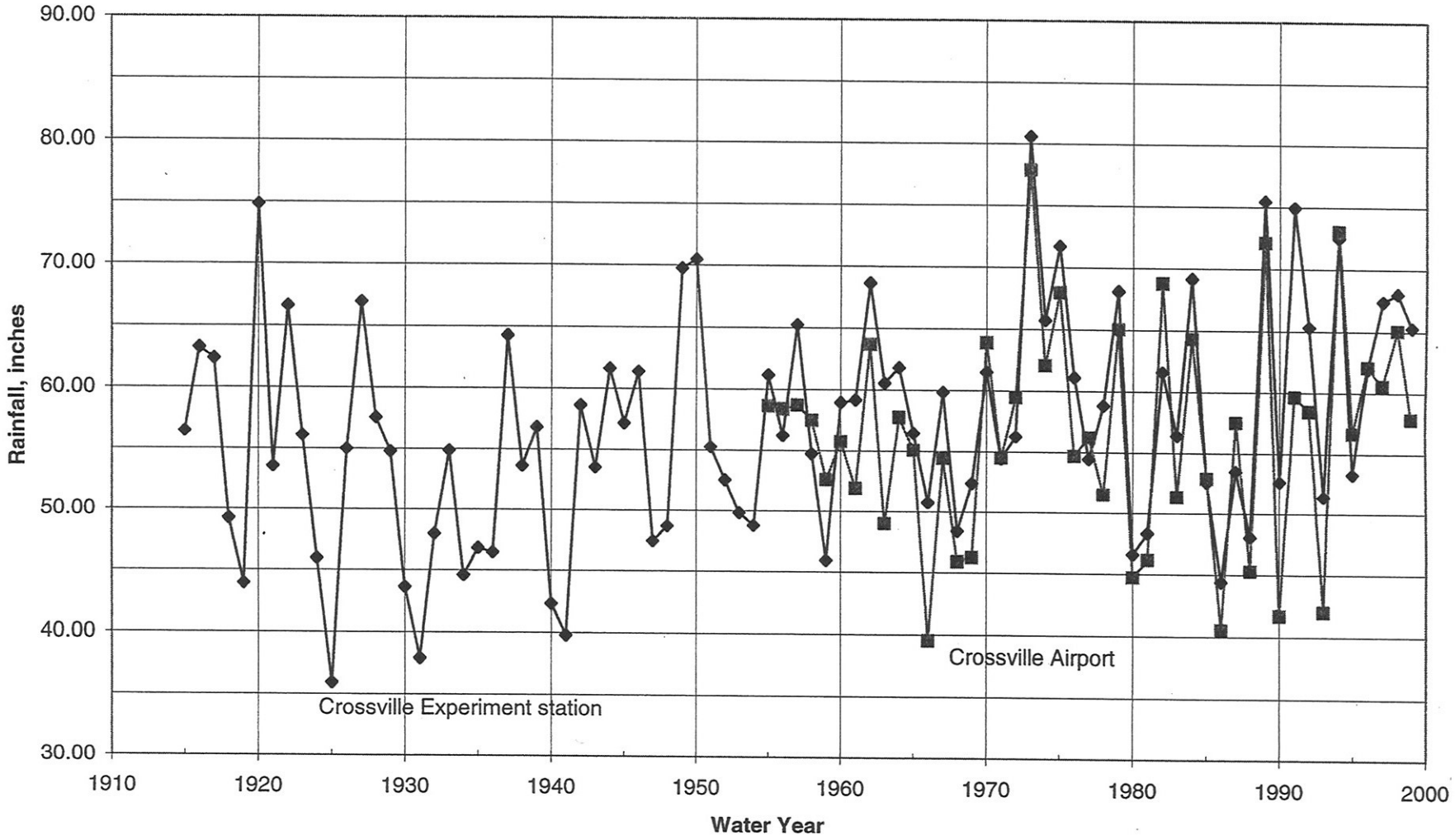


Figure 3.--Effluent release, monthly average in cubic feet per second, January 1995 to April 2002

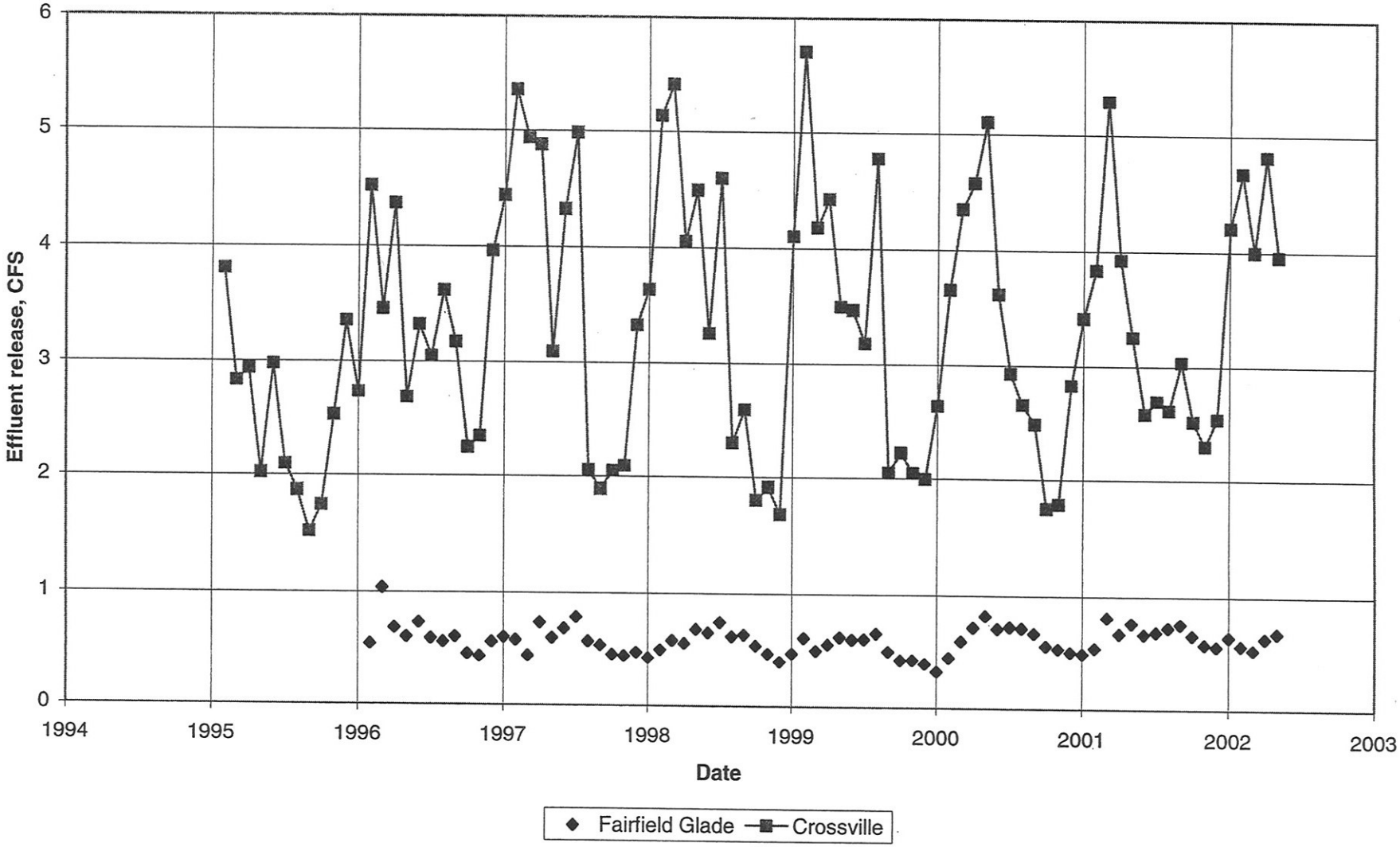


Figure 4.--Percent of flow as effluent at 03539600 and 03539800, based on monthly average data

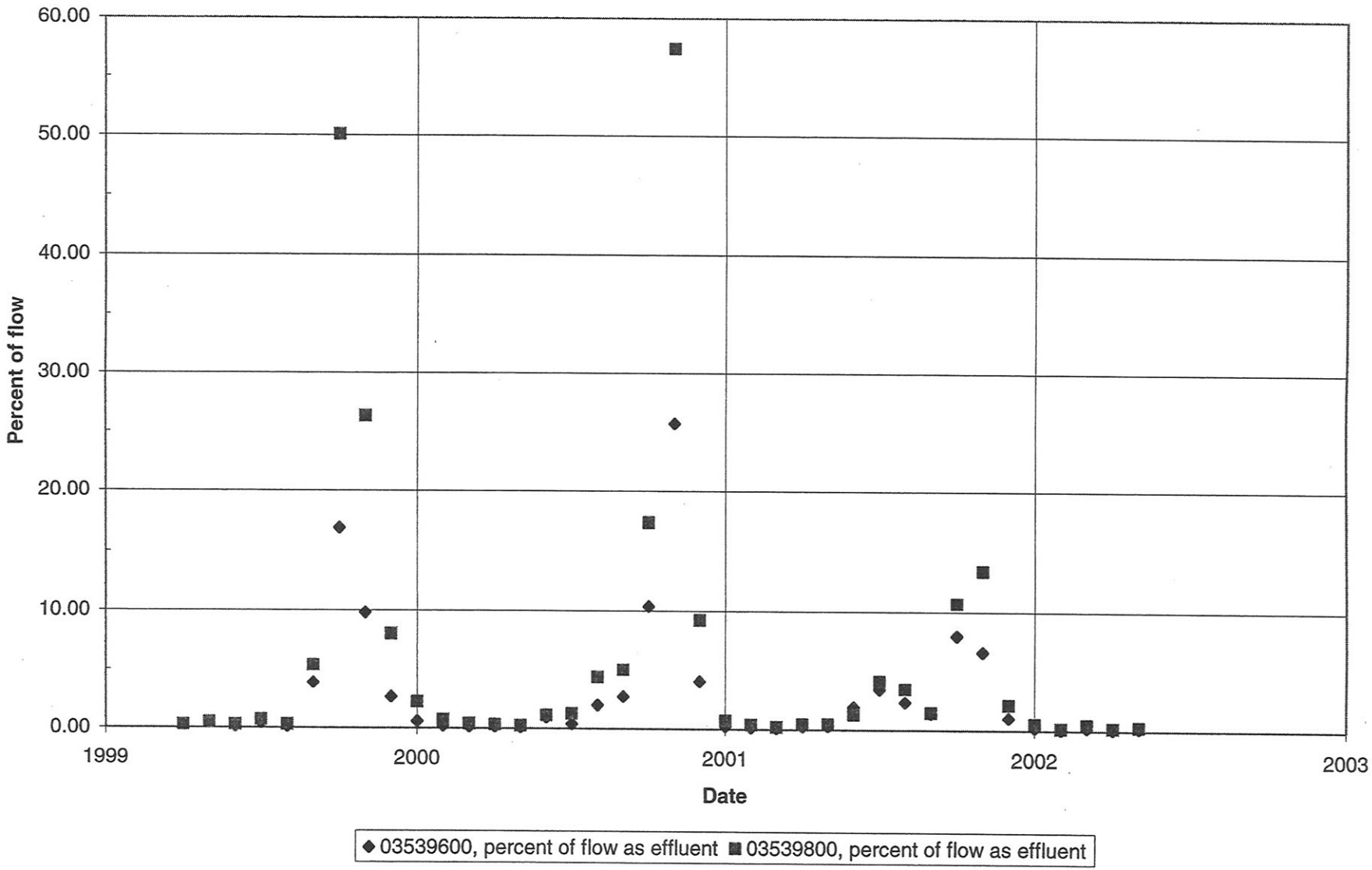


Figure 5.-- 0th percentile (daily mean values) for 03540500 Emory River at Oakdale, TN

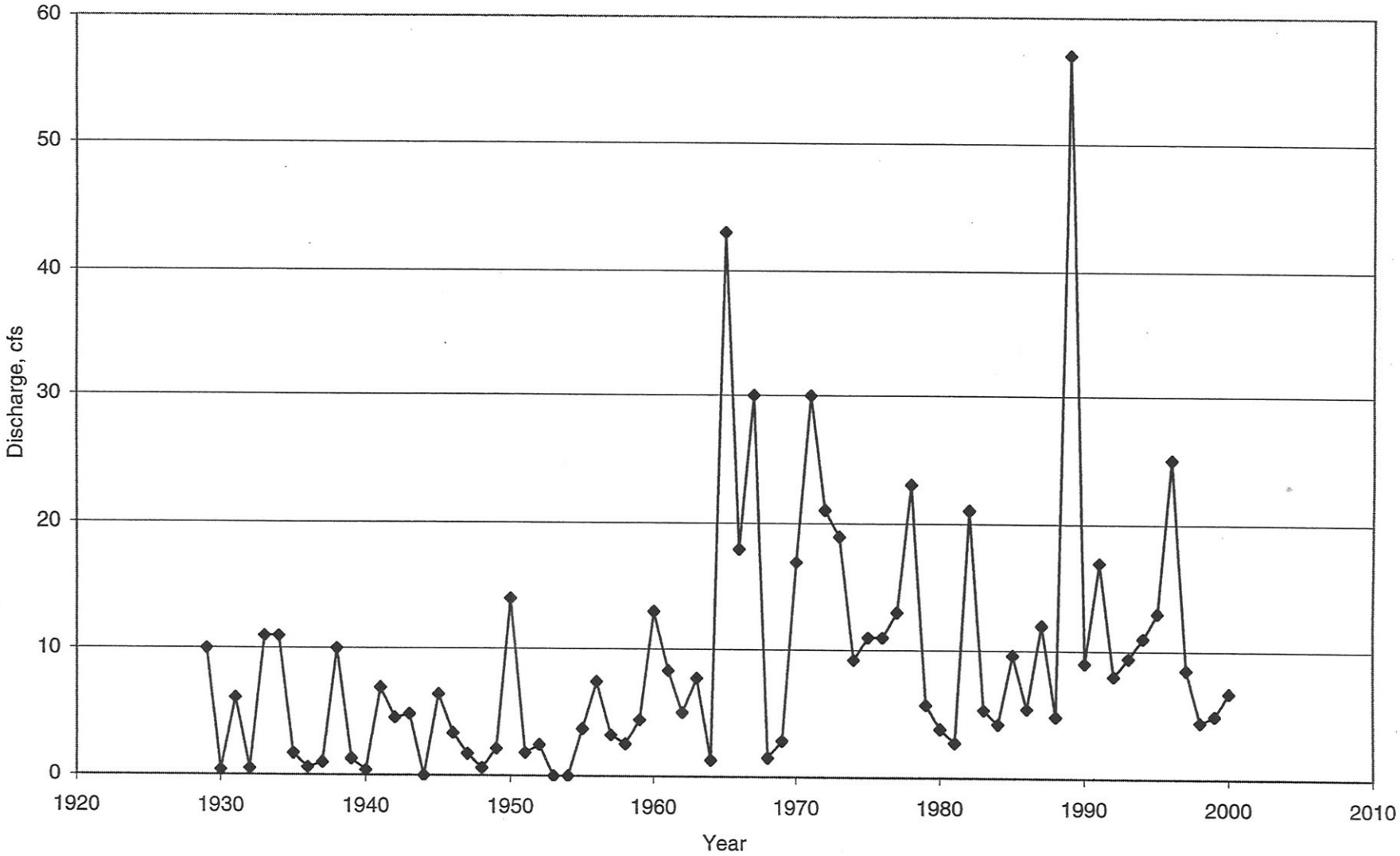


Figure 6.--10th percentile (daily mean value) for 03540500 Emory River at Oakdale, TN

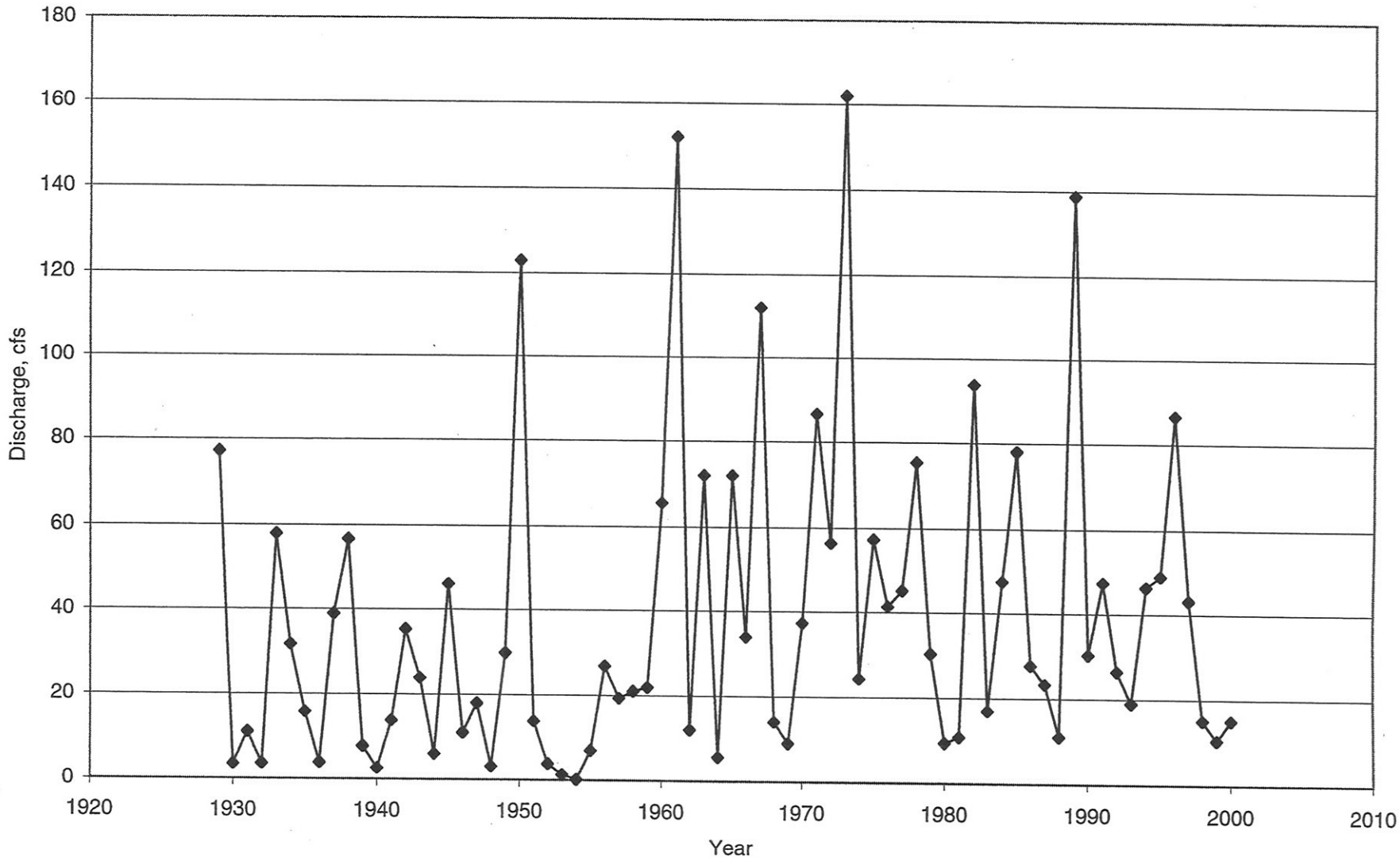


Figure 7.--30th percentile (daily mean value) for 03540500 Emory River at Oakdale, TN

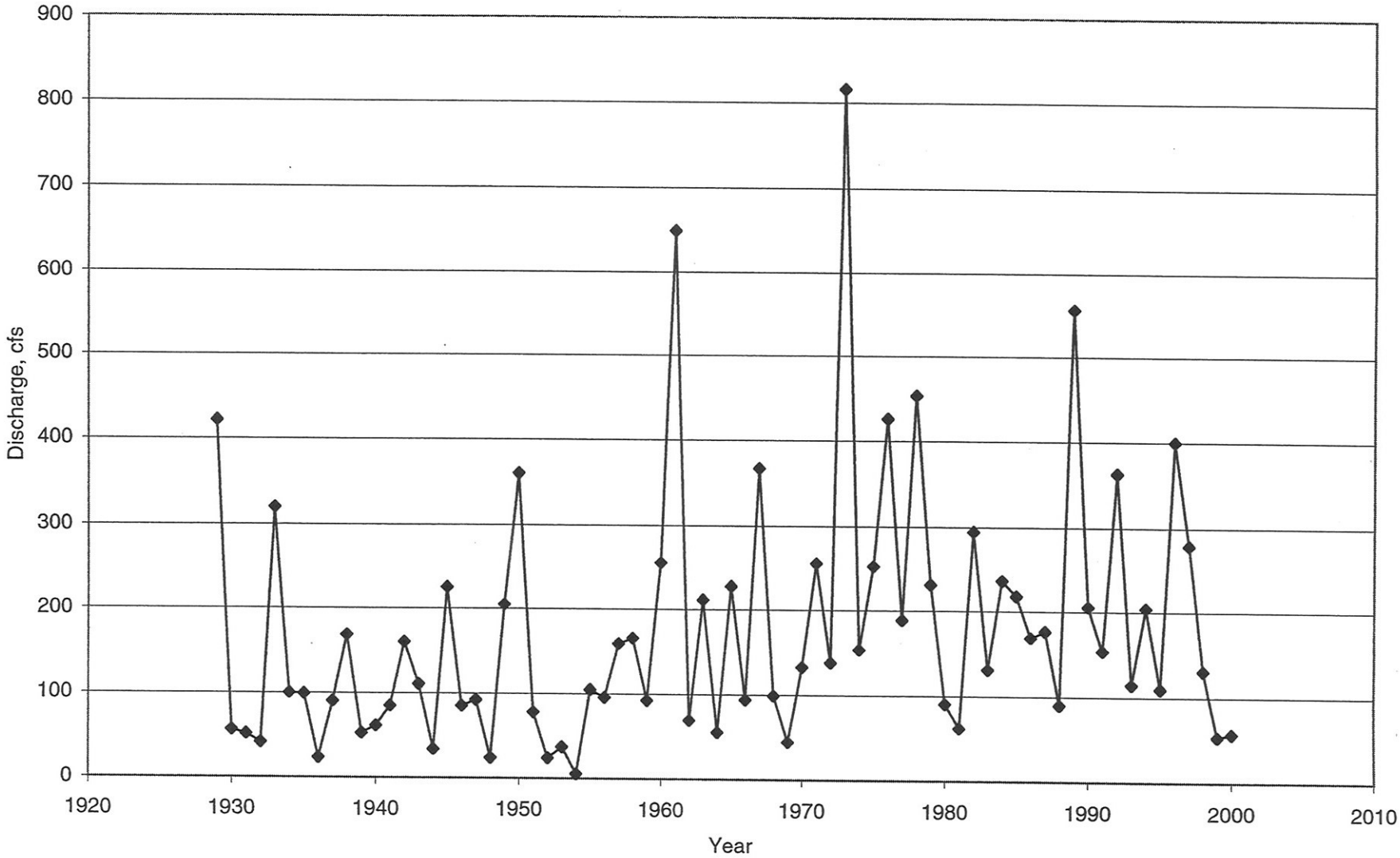


Figure 8.--Seven-day low flow means, 03540500 Emory River at Oakdale, Tennessee

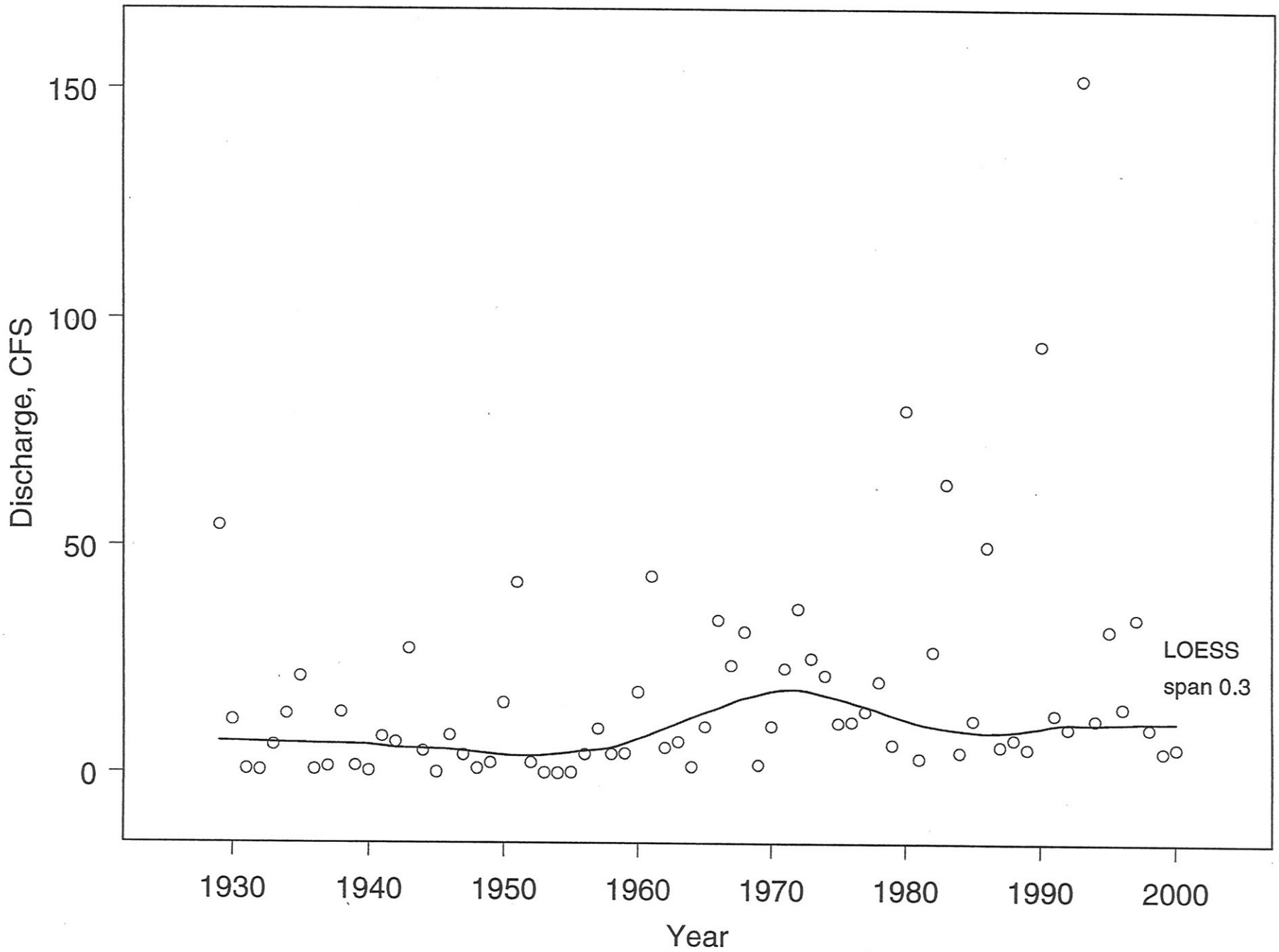


Figure 9.--Fourteen-day low flow means, 03540500 Emory River at Oakdale, Tennessee.

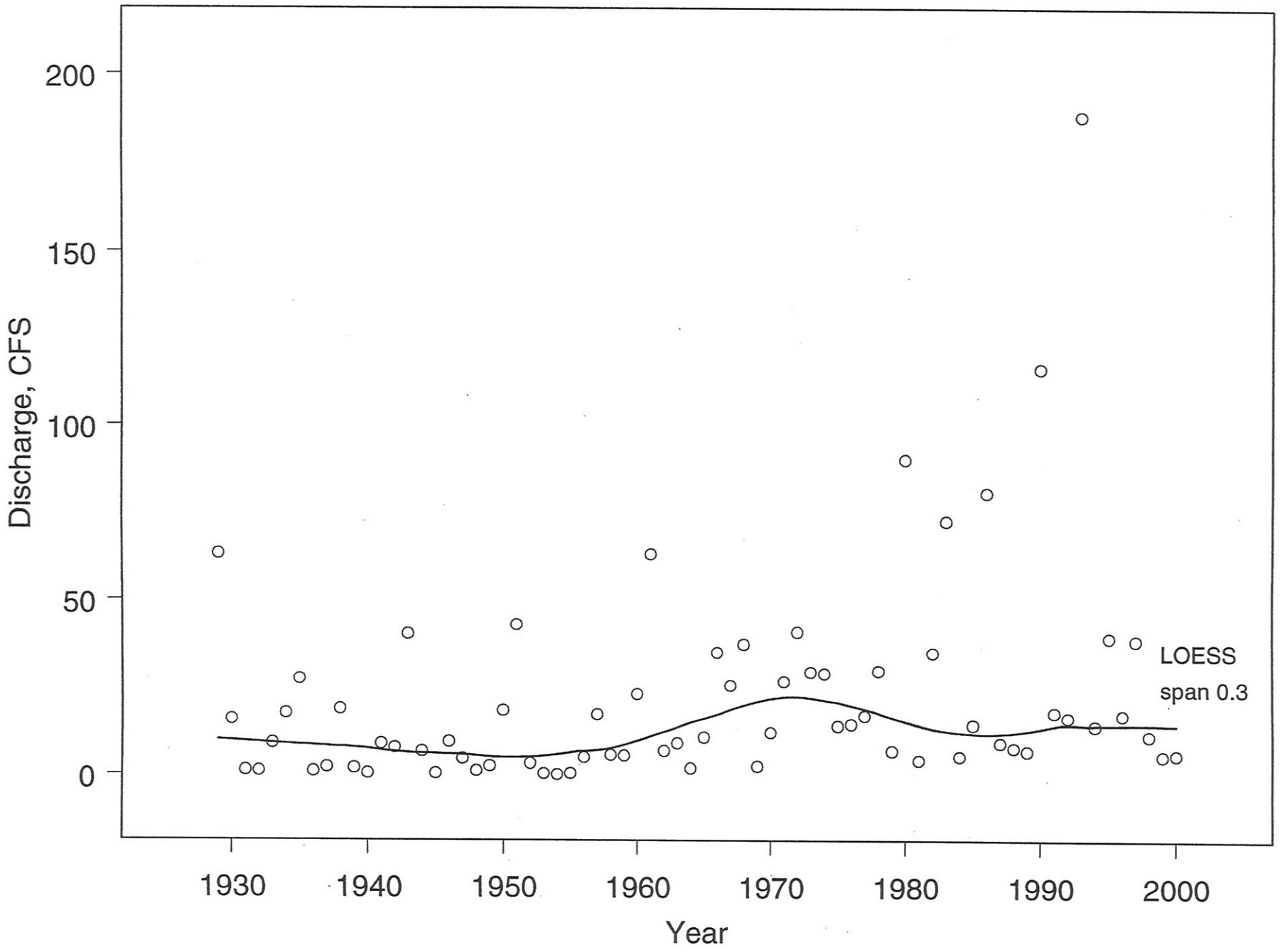


Figure 10.--Thirty-day low flow means, 03540500 Emory River at Oakdale, Tennessee

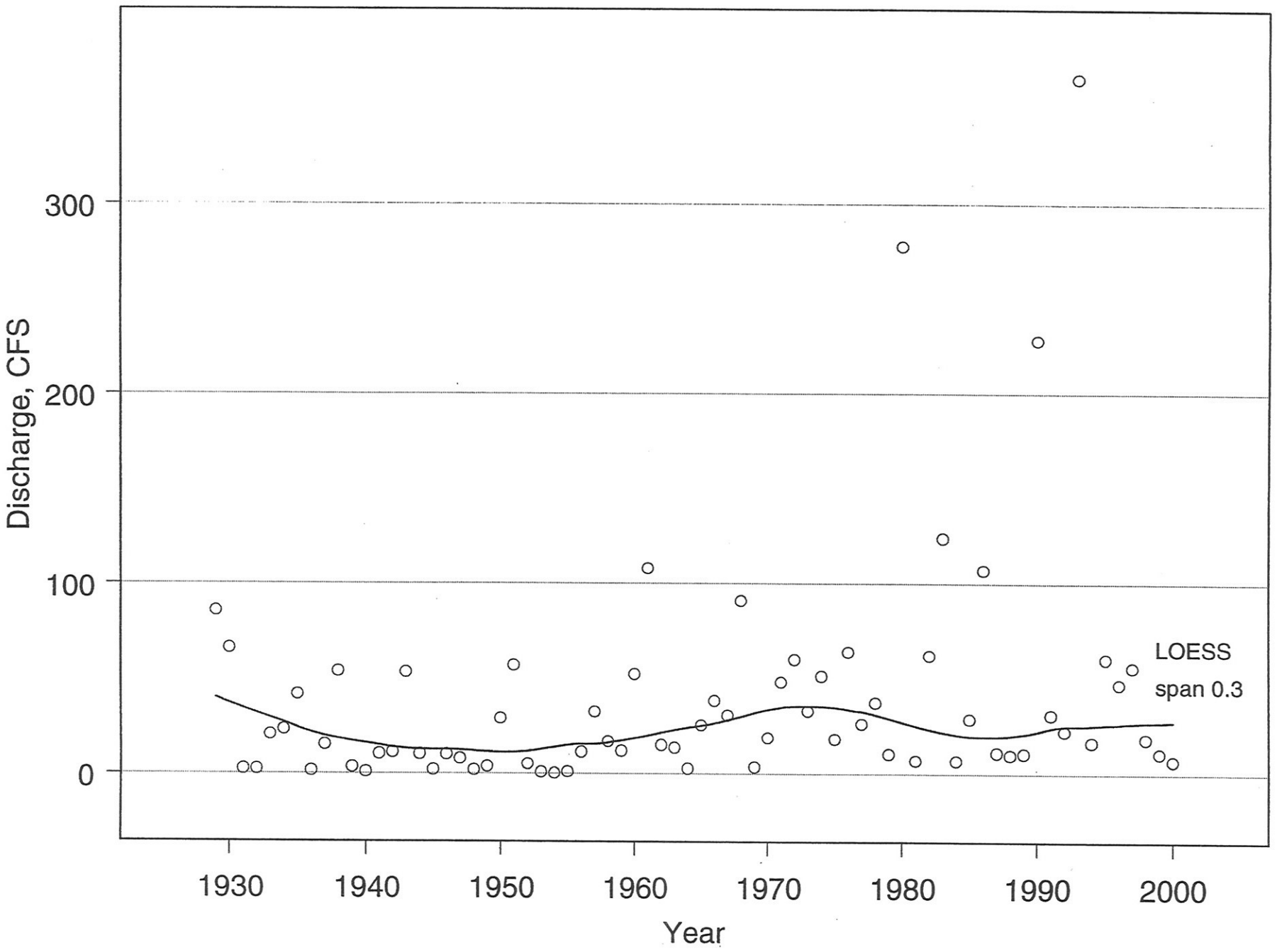


Figure 11.--70th percentile, mean-daily values, 03540500 Emory River at Oakdale, Tennessee

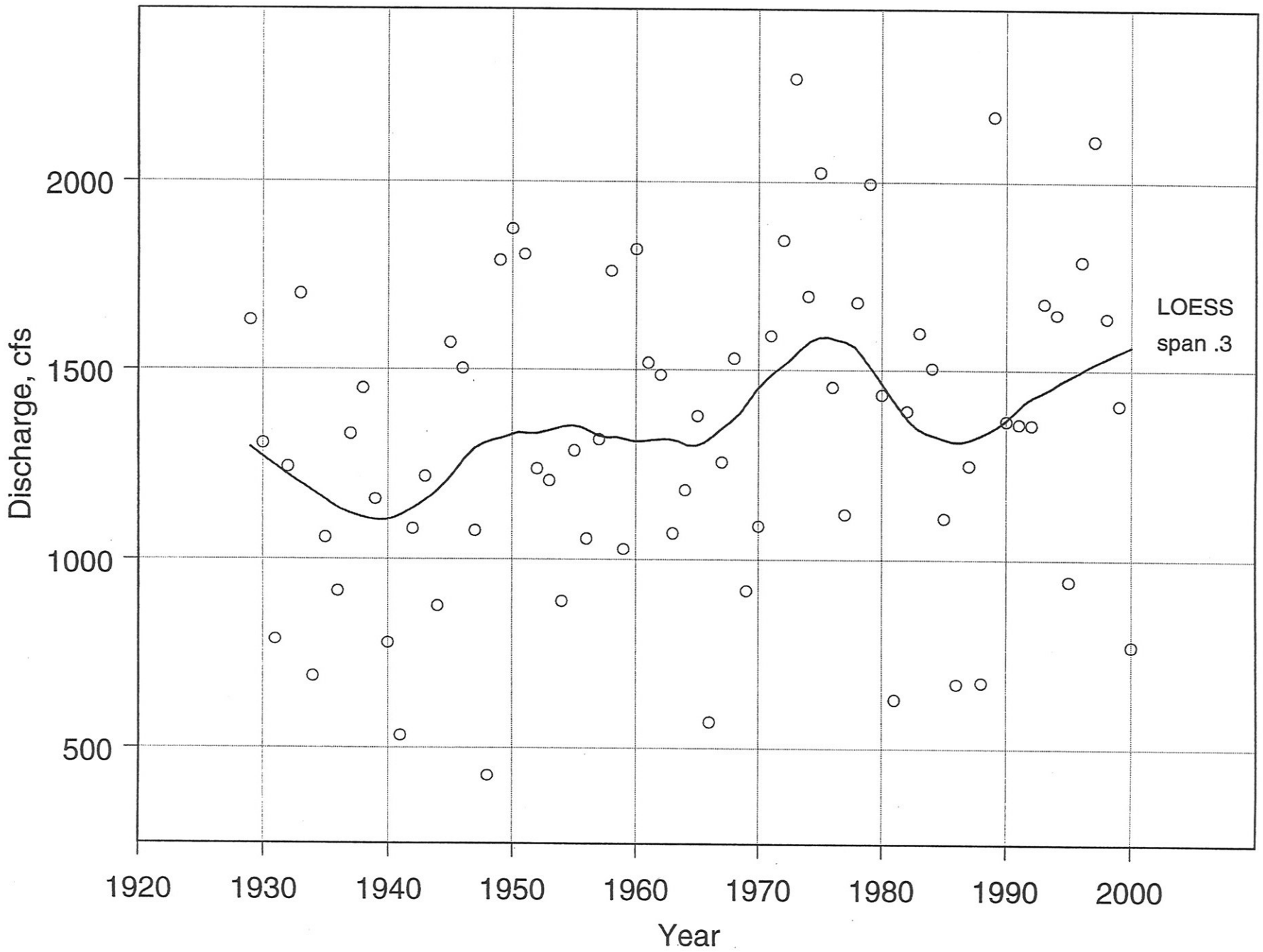


Figure 12.--100th percentile (daily mean value) for 03540500 Emory River at Oakdale

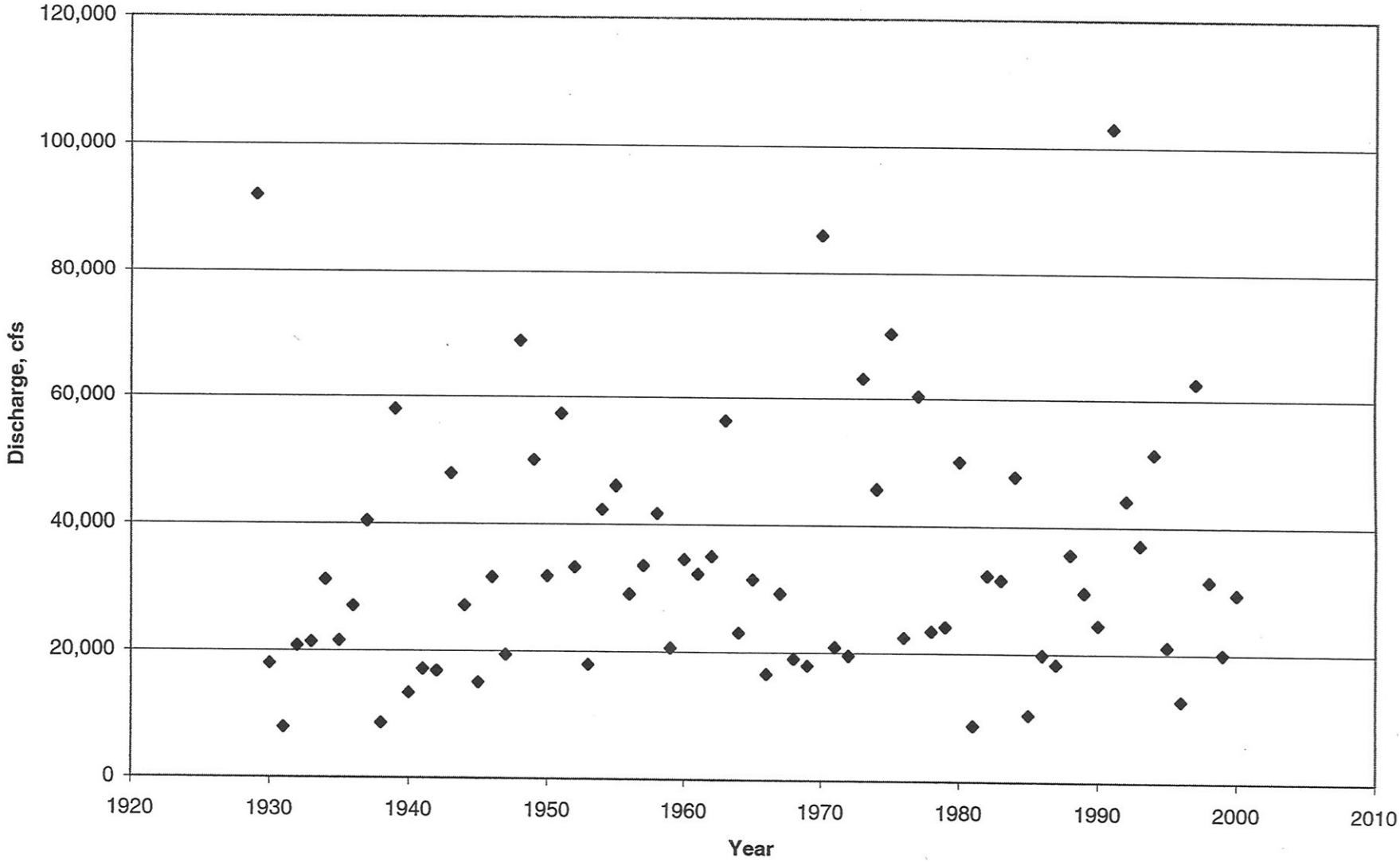


Figure 13 .--Crossville Experiment Station annual rainfall, water year

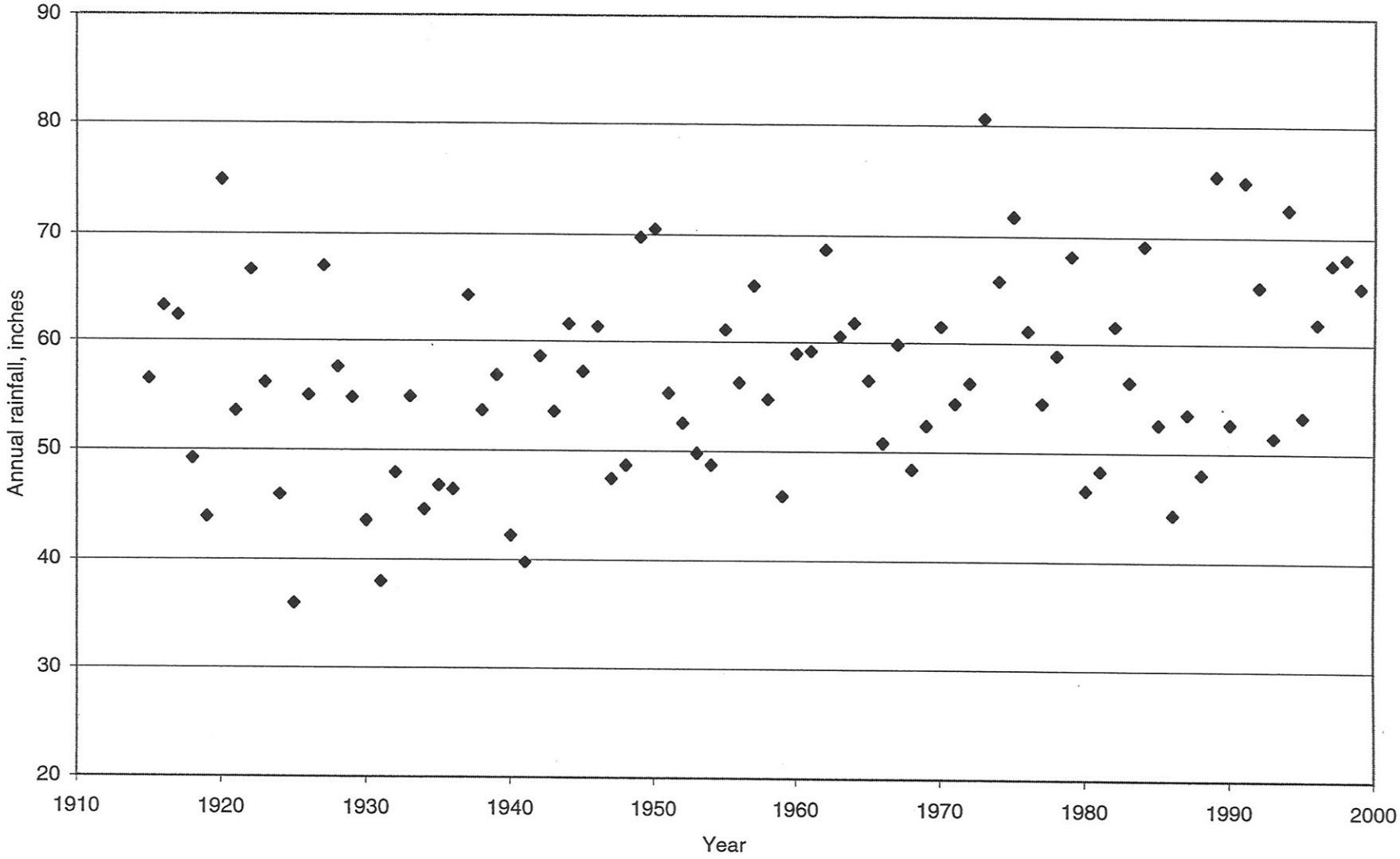


Figure 14.--Crossville Airport annual rainfall, water year

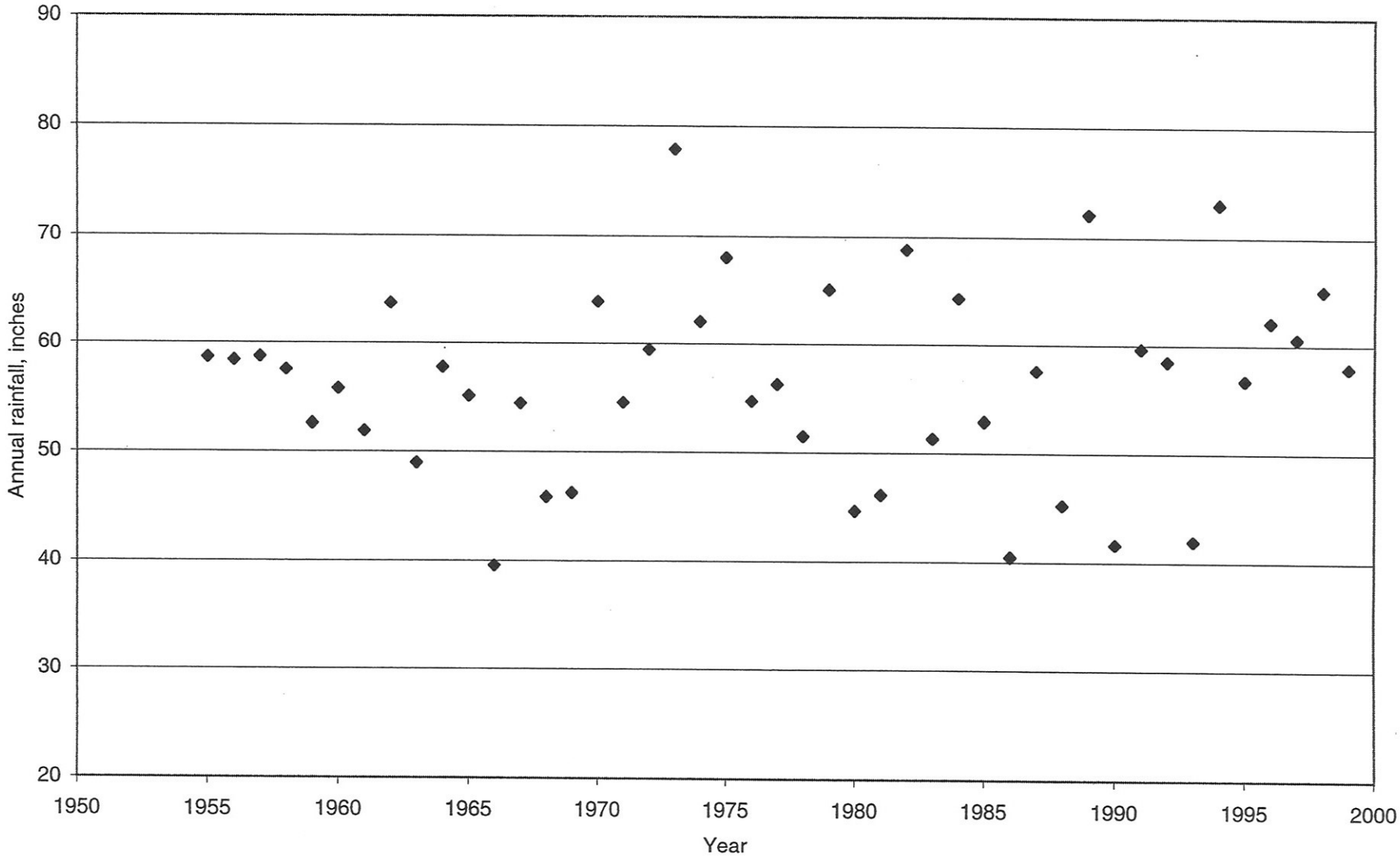


Figure 15.--Crossville Experiment Station, water-year rainfall, LOESS (span .5) defined patterns.

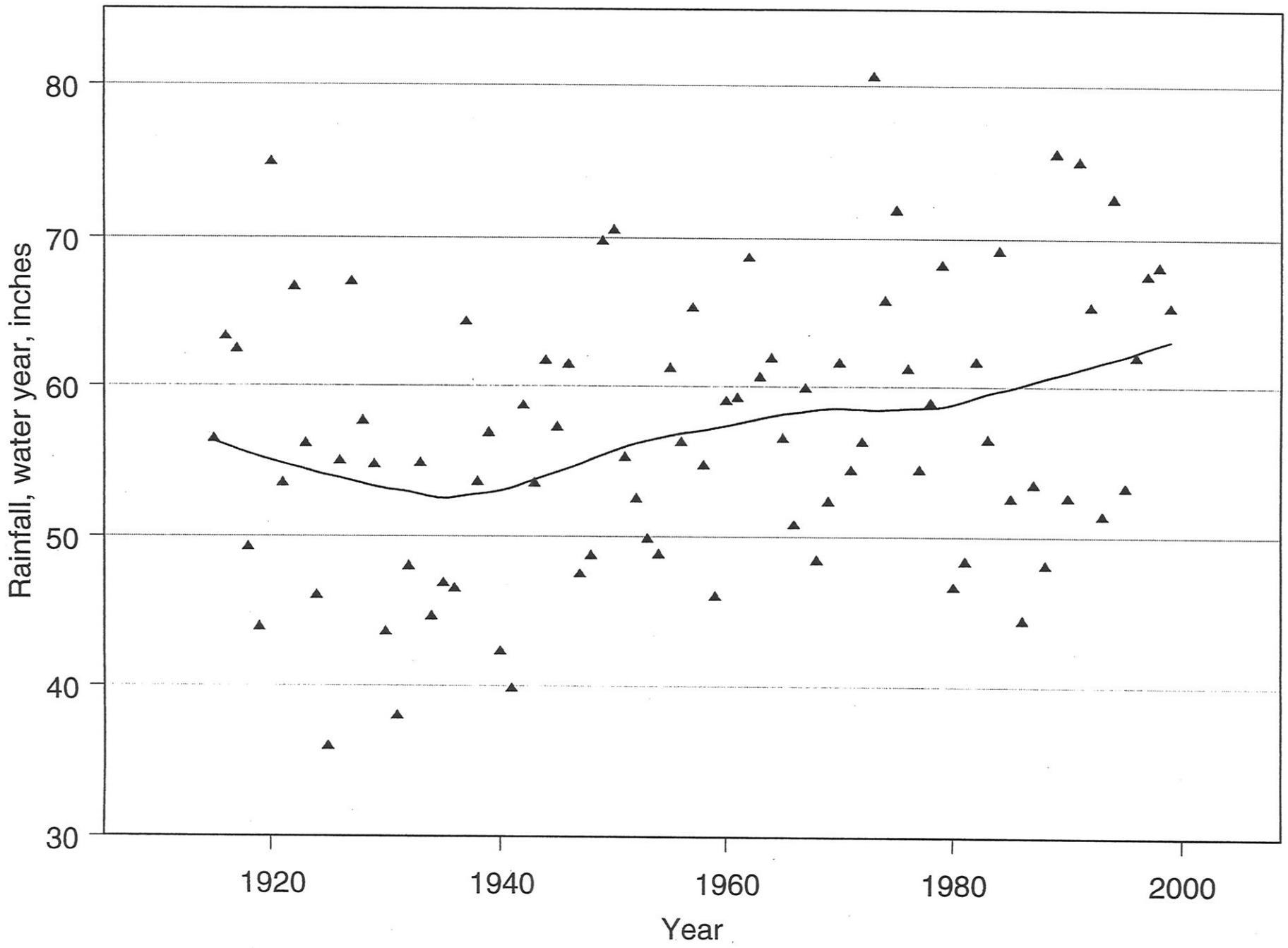


Figure 16.--Crossville Experiment Station water-year rainfall, 1929 through 1999, LOESS (span .5) defined pattern.

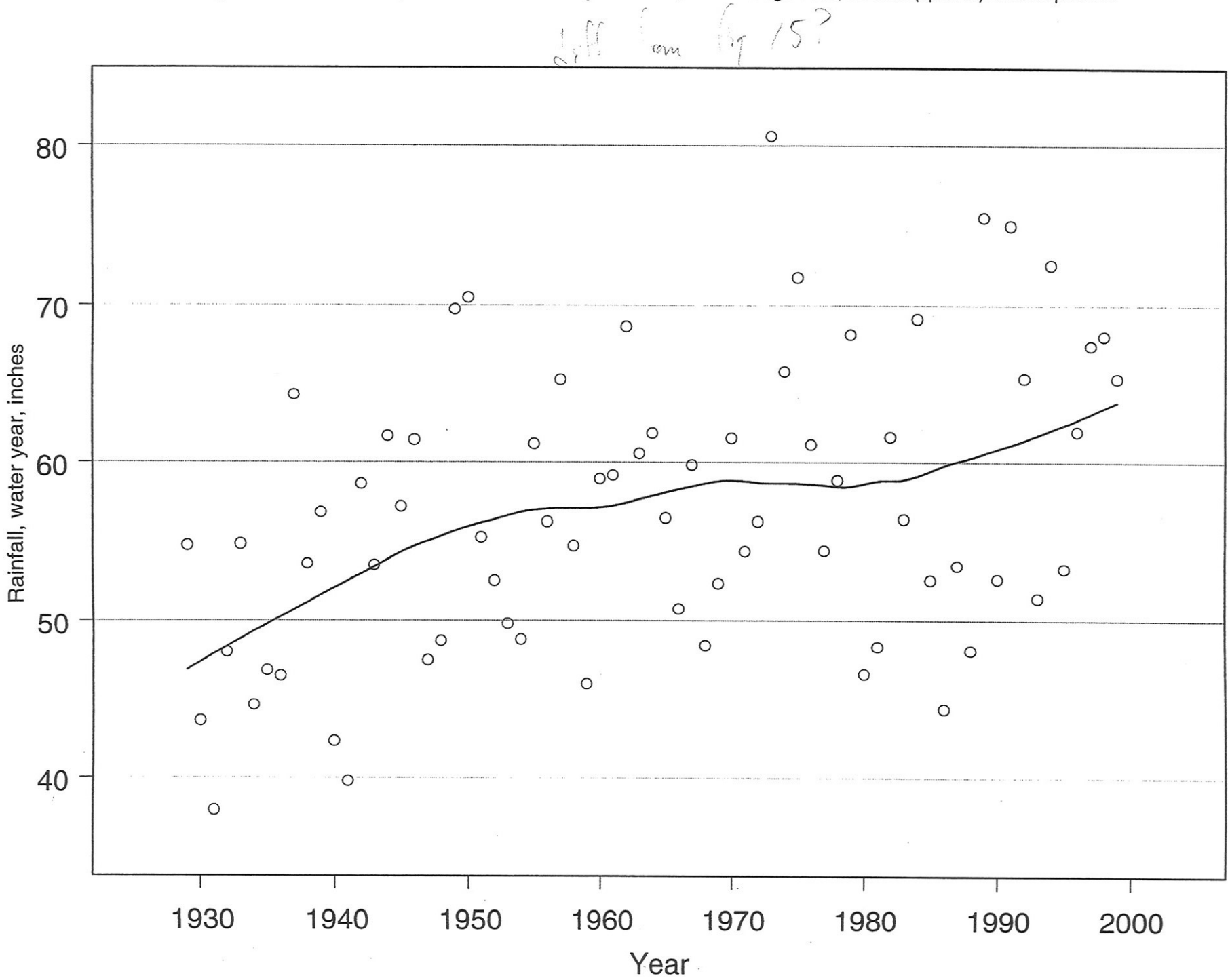


Figure 17.--Annual yield (water year) for 03540500 and 03539800.

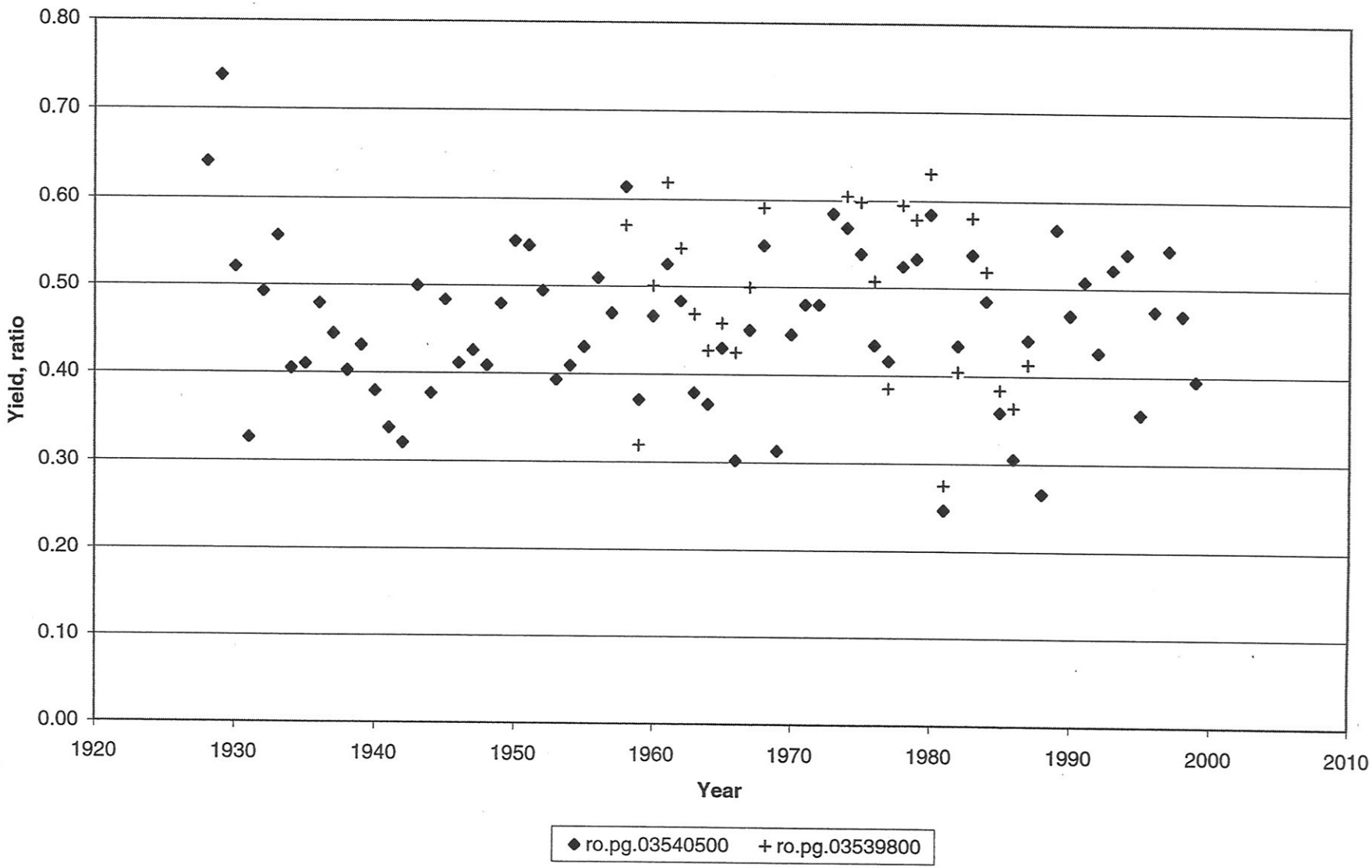


Figure 18.--Cumulative rainfall (Crossville Airport) and runoff for 03539800.

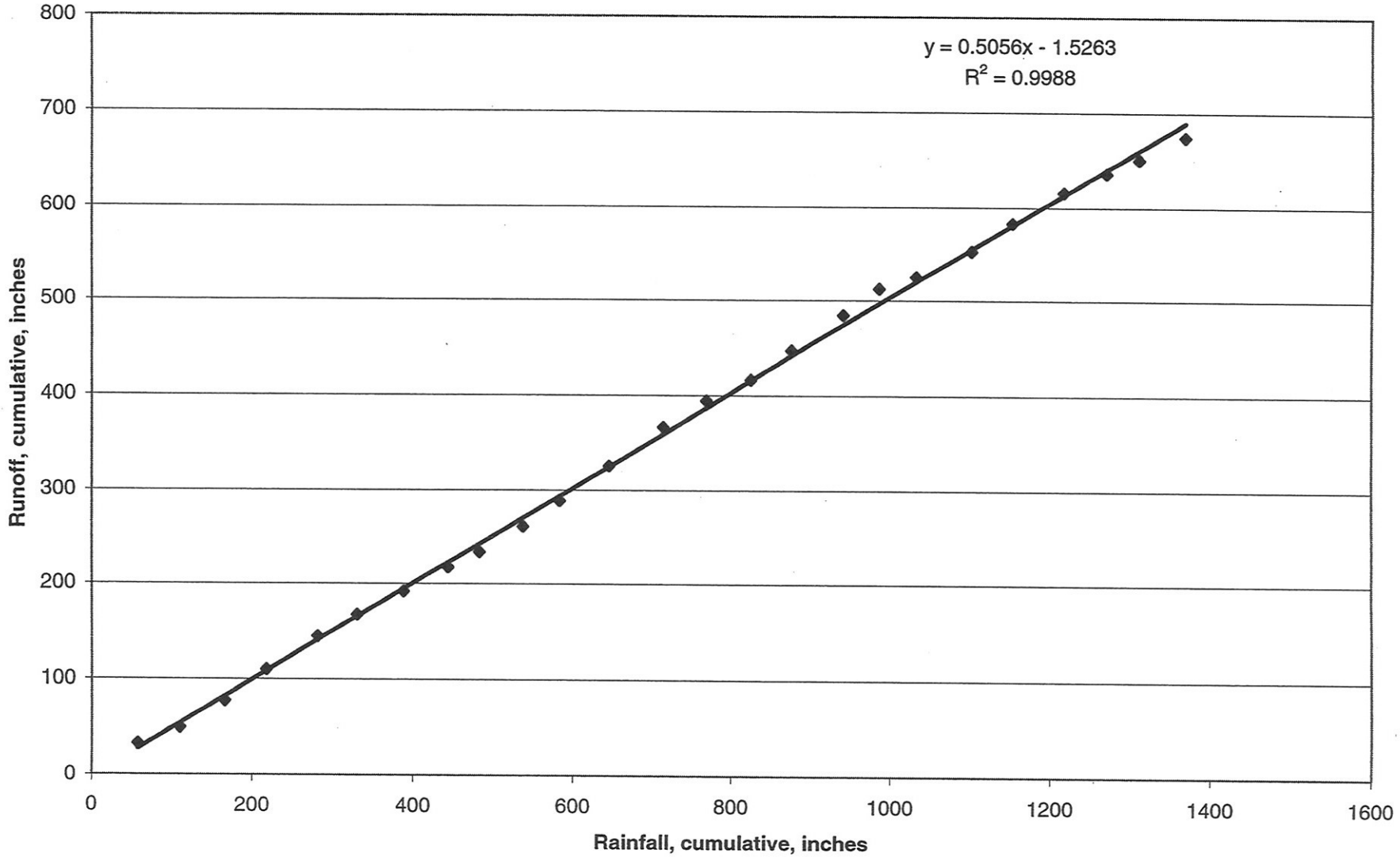


Figure 19.--Cumulative annual rainfall and runoff, water-year basis, Crossville Experiment Station and 03540500 Emory River at Oakdale

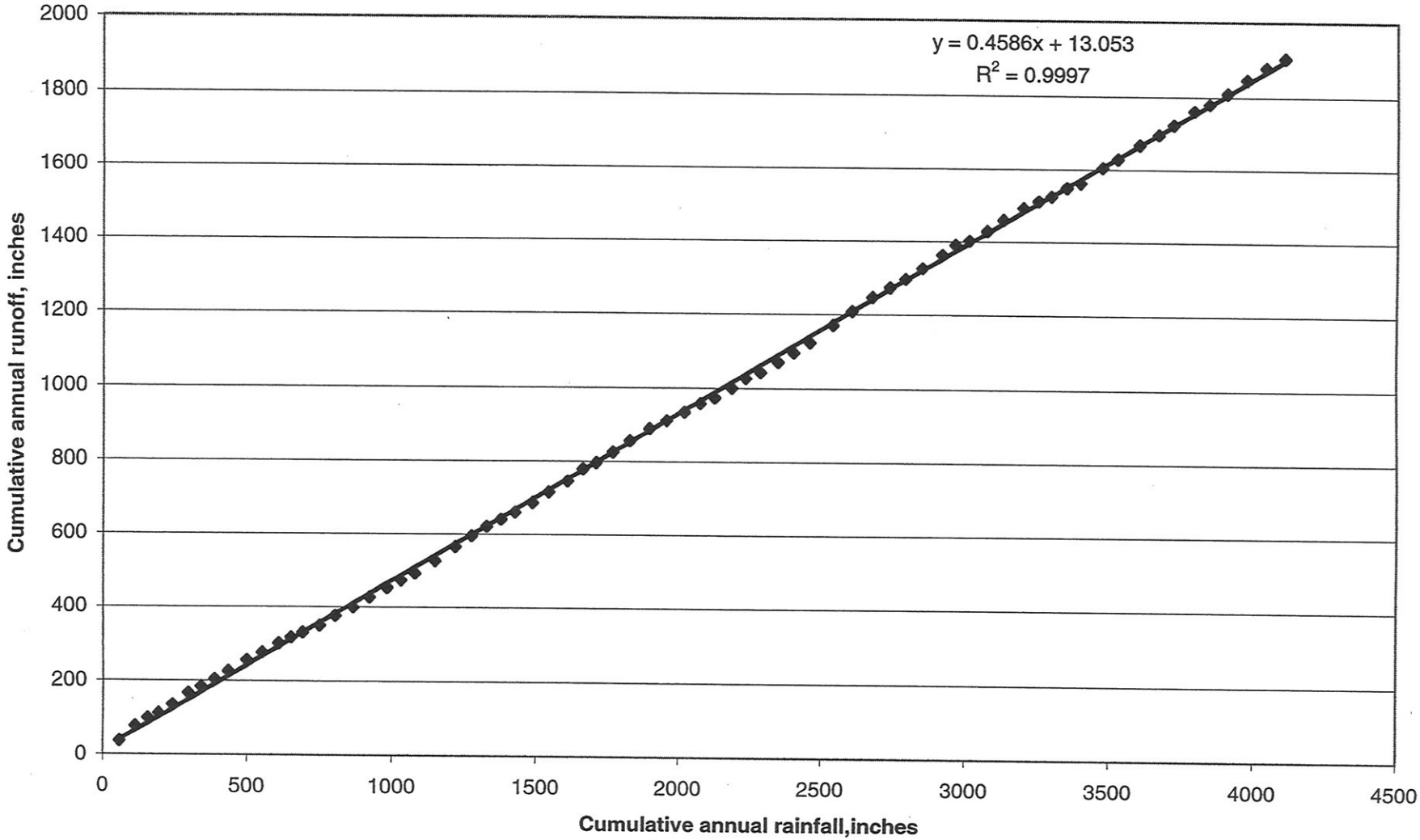


Figure 20.--Monthly runoff in inches from 03539800 and 03539600 for May 1957 to September 1968.

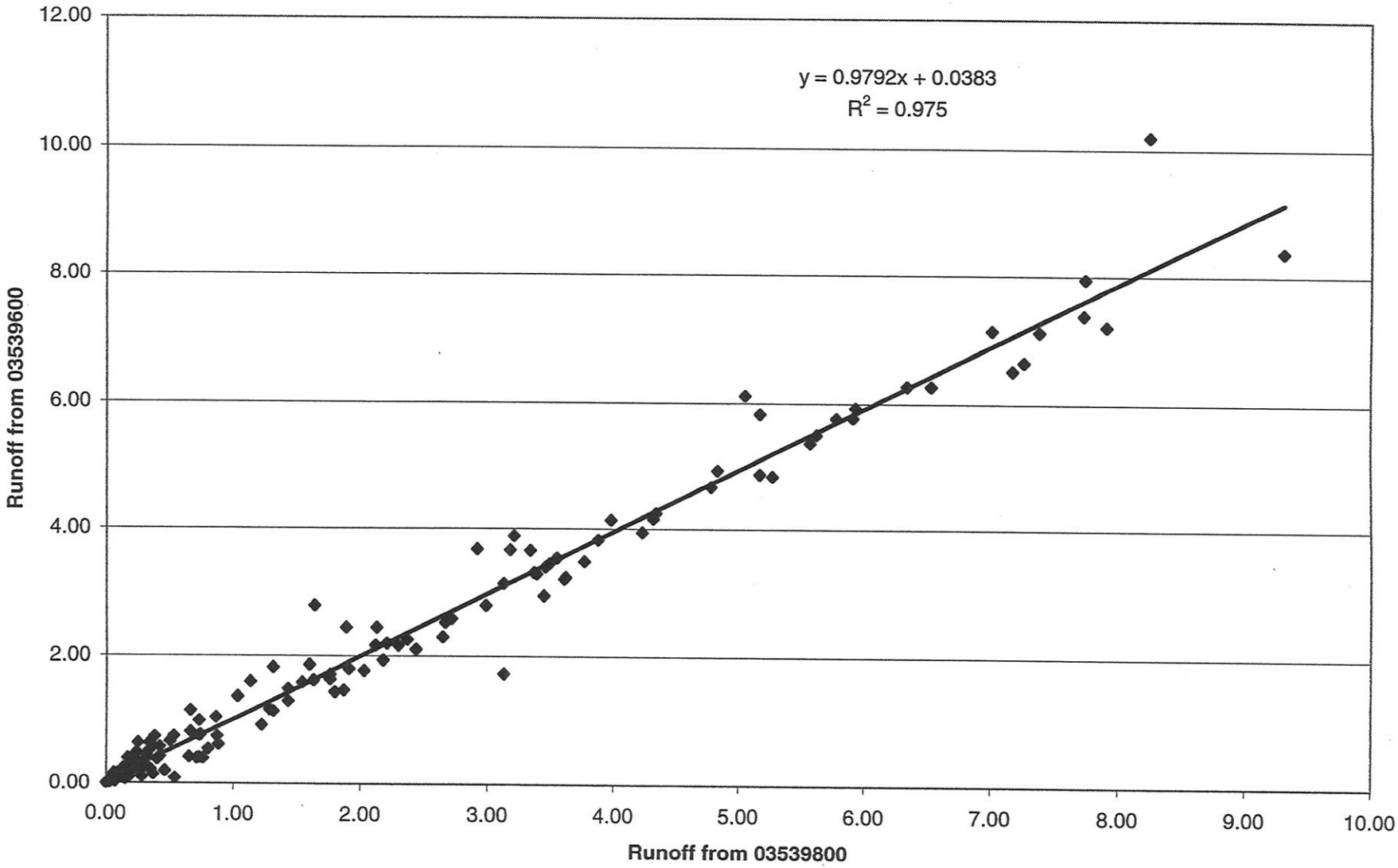


Figure 21.--Monthly runoff in inches from 03538500 and 03539500 for June 1934 to September 1957.

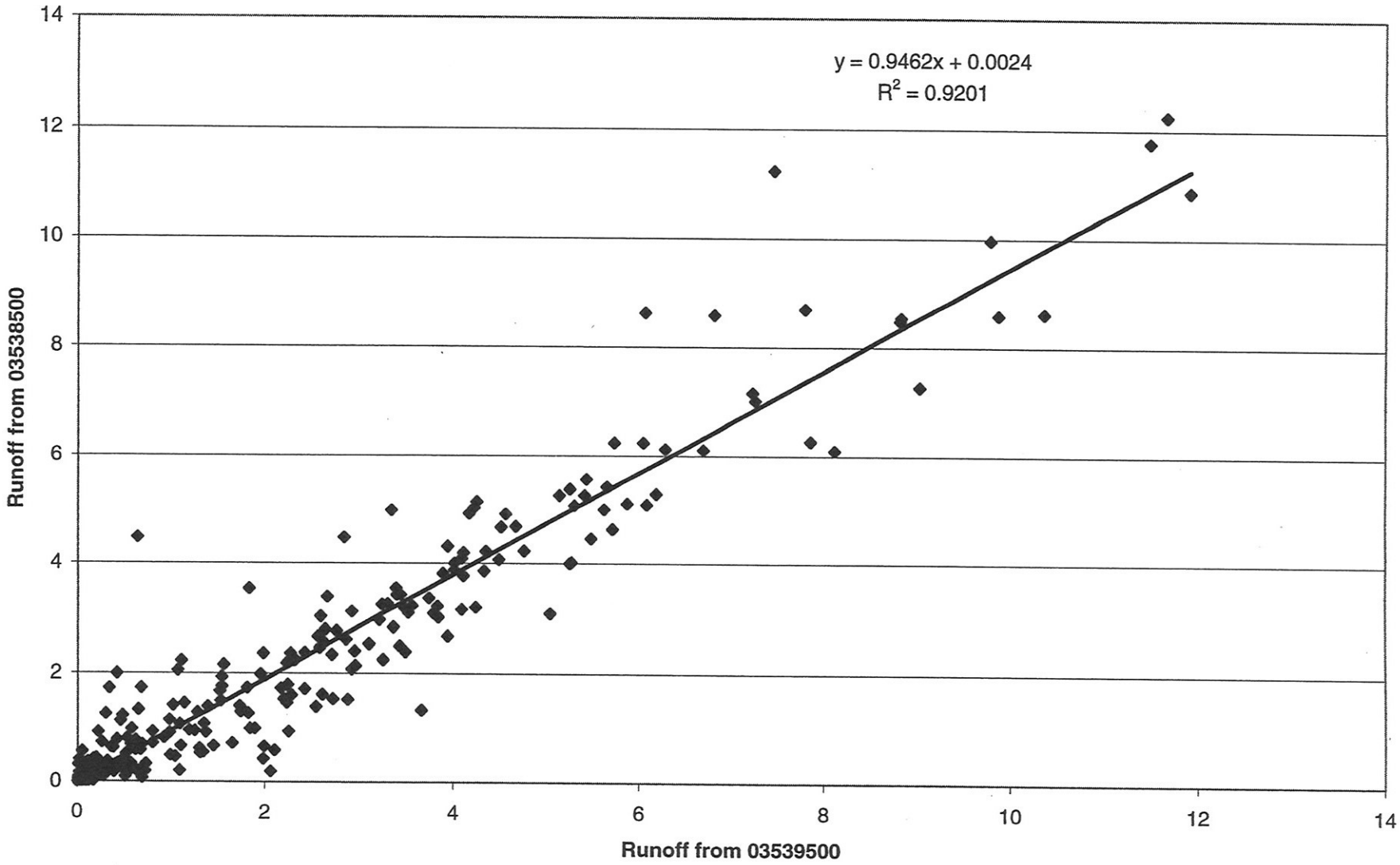


Figure 22.--Monthly runoff in inches from 03539800, 03539600, and 03539778 for May 1999 to September 2000

